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Influence of temperature and host density on functional response of *Telenomus remus* Nixon, an egg parasitoid of *Spodoptera litura* Fabricius

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ABSTRACT: The relationship between temperature and host density on functional response of *Telenomus remus* Nixon, an egg parasitoid of *Spodoptera litura* Fabricius was studied. The Holling's Type II equation described the increase in rate of parasitization by *T. remus* with increasing host density at all 6 experimental temperatures, R^2 values ranged from 0.56–0.91. The highest area searched was at 25 °C and it declined sharply with increase in temperature to 36 °C. The handling rate was minimum 3.3 eggs/h at 25 °C and maximum (4.0 eggs/h) at 36 °C. At cooler temperatures (20°–30 °C) searching capacity of parasitoids was greater as compared to warmer temperatures (32°–36 °C). The parasitoid searched greater area 873 cm^2 to 1566 cm^2 and increase in temperature resulted in reduction in area searched and at 36 °C parasitoid could search 216 cm^2 area. The search rate and handling time fitted to a quadratic function of temperature. Based on parasitoids' capacity to search the area, differential release rates during crop growth stage for cotton, cabbage and tobacco are proposed.

KEYWORDS: Density, temperature, functional response, *Telenomus remus*, *Spodoptera litura*

INTRODUCTION

Spodoptera litura (Fabricius) is a polyphagous pest and *Telenomus remus* is used against many lepidopterous pests, particularly of those of the genus in Asia and several Latin American countries (Cave, 2000). One way to evaluate the potential natural enemy is through a population growth model of the host. However, functional response of the parasitoid must be determined before realistic estimates of pest population growth can be made. The attribute that is related to parasitoid success is the searching

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efficiency of a natural enemy in relation to its prey density (Huffaker *et al.*, 1971). The functional response is defined as the relationship between the number of prey or hosts attacked by a natural enemy as a function of prey-density (Solomon, 1949; Holling, 1959a,b). The factors that influence most the performance of a natural enemy during the production and in the field efficacy are its dispersal, host searching and host acceptance behaviour traits that are regulated by crop/plant species and habitat environment and prey density and prey population dynamics. A number of studies have shown that variation in search and handling rates as a function of temperature (Messenger, 1968; Cave and Gaylor, 1989).

The purpose of the present study was to determine the functional response of *T. remus* at 7 constant temperatures (from 15° to 36 °C) and at 6 host densities (20 to 120 eggs/strip) and estimate the search and handling time that relates more closely to the field conditions.

MATERIALS AND METHODS

The culture of *T. remus* collected from the field was maintained on *S. litura* eggs. The 24 h old females not previously exposed to hosts were used for the experiment. The studies were carried out at Project Directorate of Biological Control, Bangalore.

The effect of host density on functional response was determined at 7 different constant temperatures (15°, 20°, 25°, 30°, 32°, 34° and 36° ± 0.5° C) by exposing one-mated female to six host density levels (20, 40, 60, 80, 100 and 120 eggs) for 24 hours. The egg mass of *S. litura* laid on paper was cut and the number of eggs in each mass was counted and glued on a paper strip (4 × 2 cm). The study was carried out in insect rearing cage (30 cm^3) made of transparent acrylic sheet except on two sides, which had white cloth with sleeves for handling experimental material. Each treatment (temperature and egg density) had 5 replications. The one egg card was hung from top into the cage and one mated female was released in the cage Honey solution (50%) were provided as adult feed. After 24 h of exposure, egg card strips were collected and kept in the glass vials for further observation. The observation on percent parasitism was recorded 8 days after release of parasitoid in the cage. The experiment was conducted in BOD incubators with 13:10 L: D photoperiod with light phase beginning at 0600 h.

A functional response was studied to measure the change in number of hosts parasitized in relation to changes in host density. Of the 4 types of functional responses considered, Holling Type II functional response, which is most common for arthropod system was applied. The basic functional response equation fitted was $N_a = (a \times T_t \times N)/(1 + a \times T_h \times N)$, where N_a = Number of hosts parasitised, a = Rate of parasitoid search, T_t = Total time, N = Host density, and T_h = Handling time. To use this equation, the assumption made was that the density of non-parasitised hosts remained constant during the experiment. Parasitoids may also re-handle previously parasitised hosts, although they may or may not super parasitise the hosts. Multiplying search area with the total area of insect rearing cages gave the total area that parasitoid

could search. Since development was not completed at 15 °C, it was excluded for analysis purpose.

Model was fit to the data and parameter estimates were calculated using the method of nonlinear least squares regression. The Shapiro-Wilk statistics (Shapiro and Wilk, 1965) was used to test for normality of the residuals, which is an analysis of variance test for normality.

RESULTS

The studies indicated that parasitism of *T. remus* on *S. litura* eggs was related not only to the density of prey but also to temperature. The Holling disc equation described the increase in rate of parasitization by *T. remus* with increasing host density at all 6 experimental temperatures (Fig. 1). R^2 values ranged from 0.56–0.91. An analysis of the residual, i.e. variance test for normality, indicated that functional response curves with respect to parasitisation in changing host density and temperature were normally distributed and were statistically significant ($P > 0.01$). The curve steeply rose at 20 °C and declined with rise in temperature from 25 °C to 36 °C. The slope of the curve for 25 °C appeared intermediate between 20 °C and those of the 4 warmer temperatures (30, 32, 34 and 36 °C). The steepness of the curves determines most optimum functional response at particular temperature. For temperature of 25 °C, the model predicted that most of the host eggs could be parasitised at densities < 80.

Estimated search rate was highest at 25 °C and lowest at 36 °C and search rate at 20 °C was similar to search rate at 30 °C and 32 °C. A quadratic regression model satisfactorily described the relationship of search rate with temperature, with $R^2 = 0.70$ (Fig. 2). The rate defines steepness of the curve to approach the upper asymptote and is the estimated proportion of the area searched during the experimental time. Since, the surface of the cage arena was 900 cm^2, the estimated area searched by *T. remus* was maximum (1566 cm^2) at 25 °C and least (216 cm^2) at 36 °C. The estimated search rate was 873 cm^2, 1071 cm^2 and 846 cm^2 at 20°, 30° and 32 °C, respectively.

Handling time was uniform 0.27, 0.30, 0.29, 0.28 and 0.27 for temperature 20°, 25°, 30°, 32° and 34 °C, respectively and it declined as temperature increased to 36 °C, at which the handling time was 0.25. A quadratic regression model also satisfactorily described the relationship of handling time with temperature with $R^2 = 92$ (Fig. 3). The inverse of handling time, handling rate, is upper asymptote of the functional response curve and represents the potential number of hosts that could be parasitised during experimental time. Handling rates ranged from 3.3–3.7 host eggs/hour at lower temperatures to 3.7–4.0 host eggs/hour at warmer temperatures.

DISCUSSION

The effect of temperature on functional response could be explained by the relationship between temperature and handling time (Messenger, 1968; Cave and Gaylor, 1989). Theoretically, the relationship between handling time and temperature should be U- shaped because there should exist an optimum and two temperature extremes

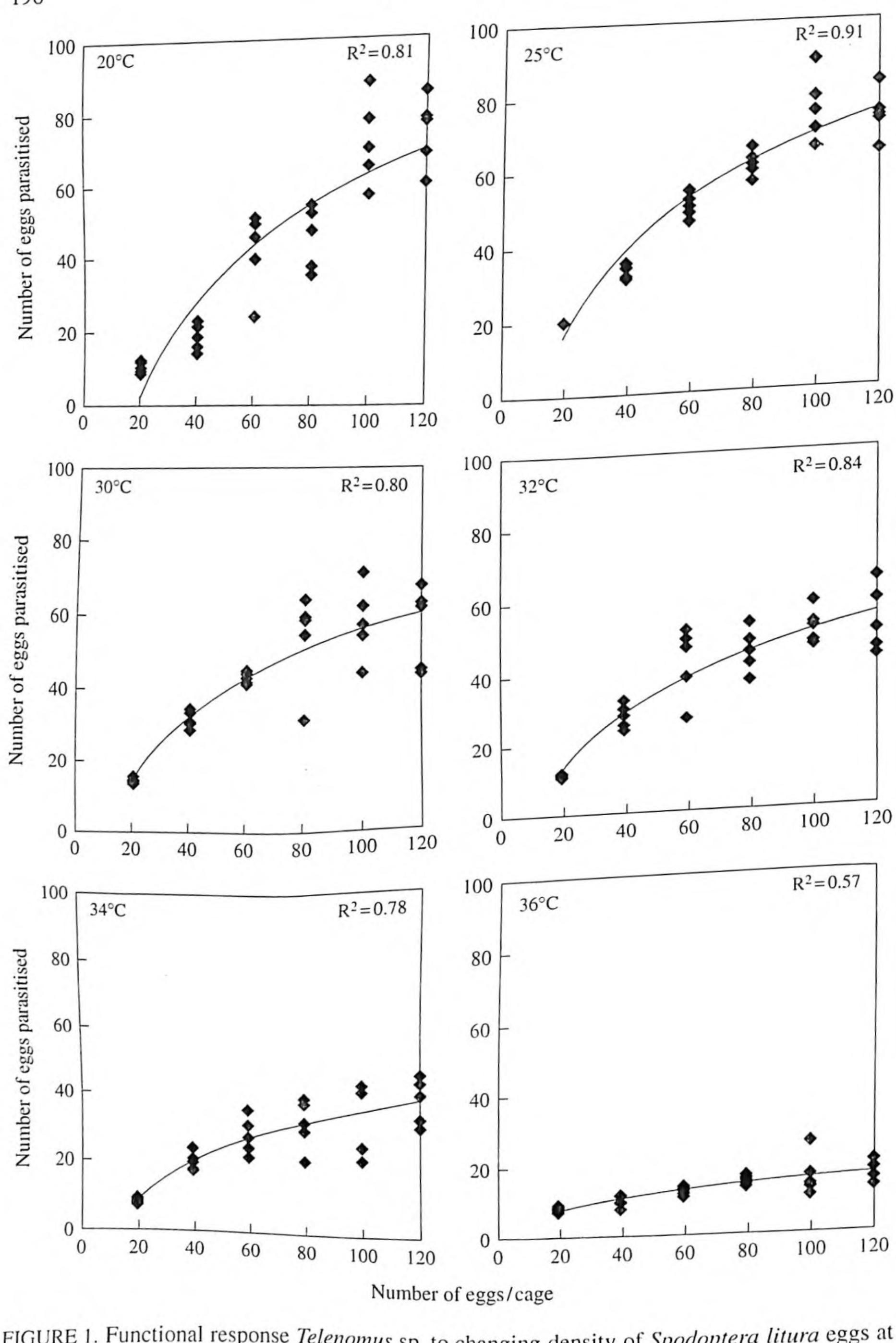

FIGURE 1. Functional response *Telenomus* sp. to changing density of *Spodoptera litura* eggs at 6 constant temperatures in a insect rearing cages.

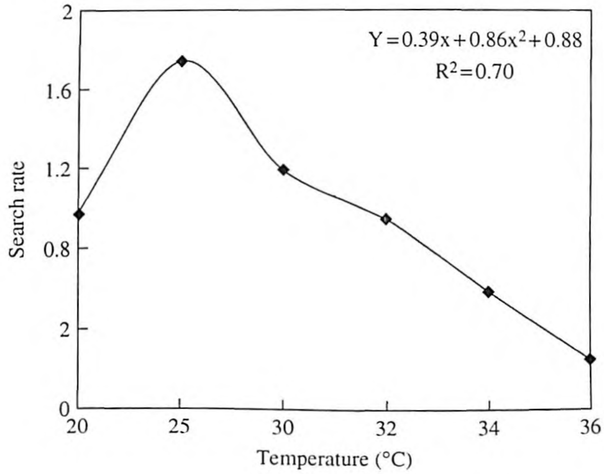

FIGURE 2. Search rate of *Telenomus* sp. as a function of temperature.

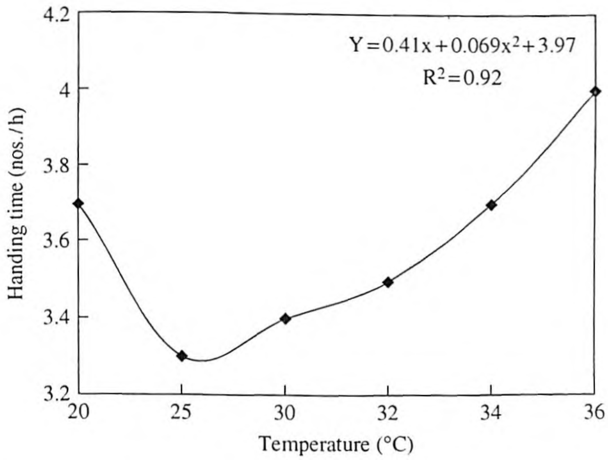

FIGURE 3. Handling time of *Telenomus* sp. as a function of temperature

at which handling time is infinite (Mack *et al.*, 1981; Runjie *et al.*, 1996). Hence, a quadratic regression equation was used to describe the relationship of these parameters with temperature (Flinn, 1991). A similar U shaped curve was obtained for handling time *Telenomus remus* in this study.

In the present study, parasitoid searched an area of 1566 and 1071 cm^2 at 25 °C and 30 °C. The surface areas of cotton plants range from 100–700 cm^2 in early season to 4,000–20,000 cm^2 in late season depending on variety, spacing and environmental conditions (Surber *et al.*, 1974). Ability to parasitise its hosts depends on the host

availability, search rate and area and the prevalent temperature. Thus, the search rate of 1566 cm^2/day by *T. remus* indicated that individual female parasitoid may be able to search up to 2 to 15 plants/day in early season and 0.07–0.3 in late season on cotton. Similarly, surface area of cabbage plants range from 35 cm^2 in early season to 8800 cm^2 in the late season. Thus female parasitoid may be able to search up to 44 plants/day in early season and 0.18 plants in the late season; the surface area of tobacco plants range from 500 cm^2 in early season to 85000 cm^2 in late season, thus female parasitoid may be able to search up to 3 plants/day in early season to 0.02 plants/day in late season in temperature around 25 °C. Crop phenology and canopy size seem to contribute significantly to the area of discovery/searchable arena apart from the decisive role played by the optimum temperature. Based on the results of searching ability, it is suggested that this factor may be taken in to consideration before making field releases of this parasitoid, though in the field some other unknown factors may also play role in searching ability of the parasitoid. Therefore, rate of parasitoid release can be altered based on ability to search the arena and the host density during crop stage. Moreover, handling time of host egg was found least between 25° to 32 °C, parasitoid could most efficiently search its host because at this range, which is also most optimum for crop growth and production.

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Evaluation of IPM technology for groundnut and sunflower based production system

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ABSTRACT: A large scale field trial was conducted to validate IPM technology for groundnut + sunflower (5:1) based production system under rainfed conditions in Raichur district of Karnataka during kharif season of 2002–03. The results showed that the IPM module consisting of seed treatment with *Trichoderma viride* Pers. ex S.F. Gray @4g/kg, foliar spray of NSKE (5%) applied at 30 days after sowing (DAS), foliar spray of sorghum leaf extract (10%) at 20 and 30 DAS, installation of pheromone traps @10/ha each for the monitoring of *Helicoverpa armigera* and *Spodoptera litura*, erecting of "T" shaped bamboo bird perches @60/ha and need based application of *Sl* NPV spray @250 LE/ha is effective pest management option and cost effectiveness (cost benefit ratio 1:1.68) and obtaining higher seed yields (6.33 q/ha) of groundnut and sunflower (3.98 q/ha) in comparison to non-IPM practices where seed yields of 5.84 q/ha of groundnut and 2.35 q/ha sunflower and cost benefit ratio 1:1.36 were obtained.

KEYWORDS: Groundnut, sunflower, IPM

INTRODUCTION

Groundnut is an important oilseed crop of India. In the international arena, with an annual production of 6.2 million tonnes in 2001, India contributed 17.7% to the world groundnut production and was ranked the second largest groundnut-producing nation after China (Basu, 2003). The productivity of the crop is lower in the country as it is grown mostly in rainfed areas and in marginal lands receiving low inputs including crop protection interventions. Insect pests and diseases cause severe losses to groundnut in India and are recognized as one of the major constraints in groundnut production (Gibbons, 1980). Sunflower has contributed significantly towards the increased oilseeds production in India in recent past. There has been decline in area

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due to reduced yield levels in the traditional sunflower growing areas especially in Karnataka and Maharashtra states (Anonymous, 1999). The sunflower crop is also susceptible to the attack of insect pests and diseases. Therefore, an attempt was made to develop and evaluate IPM technology for groundnut + sunflower (5:1) based production system under rainfed conditions.

MATERIALS AND METHODS

The trial was conducted on farmers' fields in Raichur district of Karnataka, India during kharif season of 2002–03. There were two treatments one with IPM technology and the second with insecticidal treatments. The IPM module consisted of seed treatment with *Trichoderma viride* Pers. ex S.F. Gray @ 4g/kg, foliar spray of NSKE (5%) applied at 30 DAS (days after sowing), foliar spray of sorghum leaf extract (10%) at 20 and 30 DAS, application of *Sl*NPV spray @250 LE/ha 45 DAS, installation of pheromone traps @10/ha each for the monitoring of *Helicoverpa armigera* (Hub.) and *Spodoptera litura* (Fab.) and erecting of "T" shaped bamboo bird perches @60/ha. The non-IPM treatment included two sprays of monocrotophos @0.04% at 20 and 30 DAS and one spray of phosphamidon @0.04% at 45 DAS. Groundnut (variety S-206) was intercropped with sunflower (variety Morden) at the ratio 5:1 and the sowing was done during 2nd fortnight of June, 2002 in both the treatments. Each treatment was implemented on 5.6 ha. Thus the total area under both the treatments was 11.2 ha.

The observations on the incidence of insect pests and diseases were recorded regularly. For sucking pests (leaf hopper and thrips) and leafminer, *Aproaerema modicella* (Deventer), population was recorded prior to the application of the insecticides. Per cent defoliation prior to spray of insecticide and after was recorded for *S. litura*. Percent incidence of stem rot and bud necrosis disease was recorded at 30 and 45 DAS. Observations were recorded at weekly intervals on trap catches of *H. armigera* and *S. litura*. After the harvest, the yield data was recorded. The data thus collected were subjected to statistical analysis and economics of both the treatments were also worked out.

RESULTS AND DISCUSSION

The incidence of insect pests under different treatments have been depicted in Table 1. The percentage leaf yellowing due to leaf hopper incidence was also found significantly less (20.57 and 16.42% at 30 and 70 DAS respectively) in IPM module in comparison to non-IPM practices (30.35 and 34.64% at 30 and 70 DAS respectively). The thrips, *Thrips palmi* (Karny.) incidence was significantly less in IPM module (3.52 and 2.07 thrips/terminal bud at 30 and 70 DAS respectively) in comparison to non-IPM practices (5.82 and 3.40 thrips/terminal bud at 30 and 70 DAS respectively). Defoliation due to *S. litura* and leaf damage by leafminer (*A. modicella*) under IPM module was also significantly less in comparison to non-IPM practices at 30 and 70 DAS respectively. This is due to the installation of 'T' shaped bamboo bird perches under IPM module where the predatory bird fauna preferred to visit and consumed

TABLE 1. Incidence of insect pests on groundnut crop

Treatments	Leaf hopper Av. no./plant*	Leaf hopper % leaf yellowing#		Thrips (Av. no./terminal bud)*		Leaf miner damage**		defoliation (%)# by *S. litura*	
	30 DAS	30 DAS	70 DAS	30 DAS	70 DAS	30 DAS	70 DAS	30 DAS	70 DAS
IPM Module	5.22 (2.39)	20.57 (26.99)	16.42 (23.89)	3.52 (2.04)	2.07 (1.60)	4.35	4.71	7.85 (16.32)	13.2 (21.30)
Non-IPM	7.11 (2.75)	30.35 (33.46)	34.64 (36.03)	5.82 (2.51)	3.40 (1.97)	10.75	12.21	17.50 (24.73)	23.9 (29.77)
CD at 5%	0.209	3.87	3.41	0.23	0.16	0.29	0.28	2.43	2.87
S.Em±	0.069	1.26	1.11	0.07	0.05	0.09	0.09	0.79	0.94

*Figures in the parenthesis are square root transformed values.
Figures in the parenthesis are angular transformed values.
**No. of damaged leaf lets / 20 leaf lets.
DAS: Days after sowing.

TABLE 2. Incidence of stem rot and PBND on groundnut crop

Treatments	Per cent incidence of stem rot		Per cent incidence of PBND	
	30 DAS	45 DAS	30 DAS	45 DAS
IPM Module	1.82 (7.71)	5.57 (13.69)	10.27 (18.72)	11.42 (19.73)
Non-IPM	5.84 (13.94)	9.71 (18.74)	14.00 (21.97)	19.28 (25.99)
CD at 5%	2.15	3.44	NS	2.29
S.E m±	0.70	1.12	NS	0.74

Figures in the parenthesis are square root transformed values.
DAS: Days after sowing.
PBND: Peanut bud necrosis disease.

the healthy caterpillars in comparison to the plots of non-IPM treatment where three applications of chemical insecticides were done. Use of *Sl*NPV also helped in reducing the damage due to *S. litura* under IPM module. Rajak (1999) also reported the application of NPV, installation of bird perches and use of neem pesticides as quite effective for the suppression of pests of groundnut crop.

Stem rot disease incidence was less under IPM module in comparison to non-IPM treatment (Table 2). It was due to seed treatment with *T. viride* under this treatment. The efficacy of *T. harzianum* in controlling *Sclerotium rolfsii* in many crops has been well documented (Hadar *et al.*, 1979; Elad *et al.*, 1983). The percent incidence of peanut bud necrosis disease was also less in the IPM module in comparison to the plots of non-IPM treatment (Table 2).

On sunflower intercrop, the population of *H. armigera* was significantly higher in non-IPM treatment in comparison to IPM module (Table 3). The population (eggs and adults/plant) of predator *Chrysoperla carnea* (Stephens) on sunflower crop was found significantly higher in IPM module in comparison to the plots of non-IPM treatment

TABLE 3. Insect pests and natural enemy population on sunflower crop

Treatments	*H.armigera* (Av. no. of larvae/plant)*		*C. carnea* (Av. no./plant)*	
	45 DAS	70 DAS	Eggs	Adults
IPM Module	0.64 (1.06)	0.26 (0.87)	4.85 (2.31)	1.89(1.51)
Non-IPM	2.07 (1.60)	1.08 (1.25)	1.64 (1.46)	0.75 (1.11)
CD at 5%	0.14	0.17	0.88	0.18
S.E m±	0.04	0.05	0.03	0.06

*Figures in the parenthesis are square root transformed values.
DAS: Days after sowing.

TABLE 4. Economics of IPM technology v/s non-IPM

Treatments	Yield (q/ha)		Gross returns (Rs.)	Total cost (Rs.)	Net profit (Rs.)	Cost Benefit (C:B) ratio (Rs.)
	Groundnut	Sunflower				
IPM Module	6.33	3.99	15,576	9,250	6,326	1:1.68
Non-IPM	5.84	2.35	11,708	8,600	3,108	1:1.36

Rate of groundnut crop: Rs. 1200/q; Sunflower: Rs. 2000/q

where three applications of chemical insecticides were done. IPM module recorded higher cost benefit (C:B) ratio (1:1.68) than non-IPM treatment (1:1.36). Net profit (Rs. 3,108) was less in non-IPM treatment as compared to IPM module (Rs. 6,326) due to higher cost of chemical pesticides which were used (Table 4).

Hence, It can be concluded that for groundnut + sunflower (5:1) based production system under rainfed conditions, the IPM module consisting of seed treatment with *T. viride* @4g/kg seed, foliar spray of NSKE (5%) applied at 30 DAS, foliar spray of sorghum leaf extract (10%) at 20 and 30 DAS, installation of pheromone traps @10/ha each for the monitoring of *H. armigera* and *S. litura*, erecting of "T" shaped bamboo bird perches @60/ha and application of *Sl* NPV is effective pest management option as it being environmentally safe and cost effective.

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The *multiguttata* complex of the genus *Spilarctia* Butler (Arctiinae: Arctiidae: Lepidoptera) from India

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ABSTRACT: Four new species *viz.*, *multicornutiata*, *nirmalae*, *himachalensis* and *valvata* have been sorted out from *Spilarctia multiguttata* complex and described. All the species are closely allied to *multiguttata* (Walker) as far as general maculation and ornamentation of abdomen is concerned. However, although these can be easily distinguished from each other on the basis of distinct genitalic structures. A key to the species of the *multiguttata* complex of genus is also given.

KEYWORDS: *Spilarctia*, *multiguttata*, new spec, genitalia

Introduction

As many as seventeen individuals of tiger moths having forewing with numerous series of black spots were collected from different localities of Himachal Pradesh and Uttaranchal. On tentative sorting it appeared that all these individuals belong to a single species i.e. *Spilarctia multiguttata* (Walker). But after close examination of morphological characters including genitalic structures, it became crystal clear that the species *multiguttata* (Walker) is actually a complex of different component species and all the individuals belong to five distinct species. Out of these four species could not be identified with the help of literature (Hampson, 1894, 1901; Arora and Choudhary, 1982; Holloway, 1988; Koda, 1987, 1988) and by comparisons with the identified collections of the National/International Museums. Therefore, these species are being described here for the first time in the present studies. The terminology by Klots (1970) has been followed for genitalia.

ABBREVIATIONS

1A – First anal vein; 2A – Second anal vein; ACC.SC – Accesory sac; AED – Aedeagus; ANT.APO – Anterior apophyses; CO – Costa; CRN – Cornuti; CRP.BU

– Corpus bursae; CU – Cucullus; CU_1 – First cubital vein; CU_2 – Second cubital vein; DU.BU – Ductus bursae; DU.EJ – Ductus ejaculatoris; G.P. – Genital plate; JX – Juxta; M_1 – First medial vein; M_2 – Second medial vein; M_3 – Third medial vein; PAP.A – Papilla analis; PO.APO – Posterior apophyses; R_1 – First radial vein ; R_2 – Second radial vein; R_3 – Third radial vein; R_4 – Fourth radial vein; R_5 – Fifth radial vein; RS – Radial sector; SA – Saccus; Sc – Subcosta; Sc + R_1 – Subcosta and radial vein; SIG – Signum; SL – Sacculus; TG – Tegumen; TRA – Transtilla; UN – Uncus; VES – Vesica; VIN – Vinculum; VLA – Valvula

Spilarctia multiguttata (Walker)

Hypercompa multiguttata Walker (1855), Cat. Lep. Het. 3: 657; Hampson, 1894, Moths Ind. 2: 3; id., 1901, Cat. Lep. Phal. 3: 292; Kirby, 1892, Cat. Het. 1: 239.

Male genitalia

Uncus narrow at base, rounded and highly swollen in middle, then gradually narrowing towards distal end, tip rounded, lateral margins corrugated; acrotergite present, covering lower half of uncus; fenestrula absent; tegumen long with two parallel sclerotized sheets; vinculum broad and short, narrowing towards anterior side; saccus small. Valva simple and broad; sacculus distinct; costa not defined, with one-fifth distal part narrow; a triangular projection near distal end; juxta large, rhomboidal and sclerotized, transtilla well developed and broad. Aedeagus long, anterior tip rounded, slightly narrow in middle, curved at distal end; vesica armed with two congregations of small denticles and spines; four large spines at distal end.

Female genitalia

Corpus bursae membranous balloon-shaped; four circular signa present; ductus bursae strongly sclerotized, coiled and broad at distal end; an accessory sac present; anterior apophyses very small, less than half length of posterior ones, curved at base, both pairs with their apices pointed; posterior apophyses long and narrow; papilla analis rounded and broad, fringed with fine micro and macro setae.

Wing expanse (half):	Male	:	23 mm
	Female	:	22 mm

Material examined: Himachal Pradesh: Narkanda, 2700 m, 28.vi.1995, 1♀; Solan, Nauni, 900 m, 01.viii.1994, 1♀; Sikkim: West Kameng District, Mangan, 1200 m, 07.v 1995, 1♂.

Distribution: India: N. W. Himalayas, Sikkim; Elsewhere: Nepal, Myanmar and Combodia.

Spilarctia multicornutiata n. sp.

Head with vertex covered with whitish buff scales; frons laiden with yellow scales. Antenna with scape studded with pale yellow scales; flagellum black. Eyes black.

Labial palpus porrect, reaching lower level of frons; all segments decorated with black scales, underside fringed with yellow scales.

Thorax clothed with white scales, meso and metathorax having black spots; collar and tegula dressed with pale yellow scales, spotted with black. Forewing with ground colour white, costal edge black towards base; a basal fuscous point at base of cell; a subbasal series of three fuscous spots; an antemedial series of five spots, those below cell and on vein 1A displaced outwards; a medial series of six spots, oblique outwards to lower margin of cell, then bent strongly inwards; two fuscous spots in and one on outer side of discocellulars; two postmedial series of spots, first of nine large fuscous spots, excurved below costa, second of eleven spots oblique inwards, spots below vein Cu_2 reduced; a submarginal series present from apex to vein Cu_1; a marginal series of six spots; underside suffused with fuscous; veins R_2–R_5 stalked from before upper angle of cell; M_2 originating from well above lower angle of cell; Cu_1 from well before lower angle; Cu_2 beyond two-thirds of cell. Hindwing with ground colour yellow; a medial black spot on costa and another on Sc + R1; three discoidal black spots, two on inner side and one on outer side; submarginal series of six black spots from apex to 2A; marginal area from vein RS to Cu_2 suffused with fuscous; M_2 originating from well above lower angle of cell; Cu_1 from before lower angle of cell; Cu_2 from well beyond middle of cell. Legs dressed with black scales, fore coxae decorated with yellow scales on sides; mid and hind coxae laiden with pale yellow scales; tibial spurs almost of equal length.

Abdomen furnished with orange yellow scales, underside with pale yellow scales; a dorsal, lateral, sublateral series of black spots present.

Male genitalia

Uncus swollen and rounded dorsally ending into a triangular, narrow sclerotized distal end, slightly curved, tip blunt, appears pointed when seen laterally, dorsally setosed with fine setae; a semisclerotized circular acrotergite; fenestrula absent; tegumen long and narrow; vinculum broad and narrow anteriorly; saccus reduced. Valva simple, broad; sacculus and costa slightly defined; saccular margin with a rounded projection at distal end; upper one-thirds of valva produced into a slender and narrow projection; cucullus and valvula not distinct; juxta broad at base, dilated in middle, tip rounded; transtilla broad and sclerotized. Aedeagus long, slender with slightly curved distal end; vesica armed with congregations of denticles and numerous spine-like cornuti in middle and at distal end.

Female genitalia

Not examined.

Wing expanse (half): Male : 19 mm

Material examined
Holotype: Himachal Pradesh: Kalpa, 3000 m, 02.vii.1995, 1♂.

Paratype: Himachal Pradesh: Solan, Nauni, 900 m, 01.viii.1994, 1♂.

Remarks:

The new species *multicornutiata* is closely allied to *multiguttata* (Walker) with respect to wing venation, maculation and ornamentation of legs and abdomen. However, it differs in general coloration of collar and tegula; subbasal and medial spots of forewing; distinct valva of male genitalia and armature of vesica in aedeagus.

Etymology:

The name of the species pertains to cornuti in vesica of aedeagus in male genitalia.

***Spilarctia nirmalae* n. sp.**

Head with vertex covered with pale yellow scales; frons decorated with yellow scales. Antenna with scape having pale yellow scales; flagellum black. Eyes golden brown. Labial palpus porrect, reaching lower level of frons; all segments dressed with black scales, fringed with yellow scales on underside.

Thorax clothed with white scales, meso and metathorax having black spots; collar and tegula dressed with pale yellow scales, spotted with black. Forewing with ground colour white, costal edge black upto middle; three subbasal black spots; an antemedial series of five black spots, those below cell and on vein 1A displaced outwards; a medial excurved series of five spots; three spots around discocellulars; two postmedial series of spots, first of nine black spots, excurved to vein M_3, then strongly incurved, second oblique series of eleven black spots; a submarginal series present from apex to vein Cu_1, on each side of veins, those below R_5 and on both sides of M_1 displaced inwards; marginal series of six spots; underside suffused with fuscous except basal and anal area; veins R_2–R_5 stalked from upper angle of cell; M_2 originating from just above lower angle of cell; Cu_1 from well before lower angle; Cu_2 beyond two-thirds of cell. Hindwing with ground colour yellow; submarginal black spots on vein M_2 and below vein 2A; underside with antemedial spot on costa, medial spot on costa and below vein $Sc + R_1$; a spot on discocellulars; fuscous spots on veins R_5, M_2 and below 2A; marginal spot on M_1; vein Rs originating from well before upper angle of cell; M_2 from well above lower angle; Cu_1 from before lower angle of cell; Cu_2 from two-thirds of cell. Legs clothed with black scales, tarsi streaked with pale yellow scales on inner side; outer tibial spurs shorter than inner ones.

Abdomen furnished with yellow scales, underside with pale yellow scales; a dorsal, lateral, sublateral series of black spots present.

Male genitalia

Uncus broad and rounded in middle, pointed towards tip, lateral margins crispate, dorsally setosed; acrotergite well developed; fenestrula absent; tegumen well sclerotized, both of its arms narrow and parallel, inverted U-shaped; vinculum short, V-shaped with flap like expansions; saccus small. Valva asymmetrical; sacculus and costa poorly defined; saccular margin bilobed in right valva, however, left valva with a single rounded

projection; distal one-fourth of valva narrow with a slightly produced triangular projection; cucullus and valvula not distinct; juxta large, constricted below middle portion; transtilla long and well developed. Aedeagus long and narrow, cylindrical slightly curved distal end; vesica armed with congregations of very small spines and denticles; four small and seventeen long distinct spines at distal end.

Female genitalia

Not examined.

Wing expanse (half): Male : 17 mm

Material examined
Holotype: Uttaranchal: Chakrata, 2100 m, 15.vi.1994, 1♂.

Paratype: Uttaranchal: Almora, 1870m, 06.vi.1995, 1♂; LoharKhet, 1753 m, 10.vi.1995, 1♂.

Remarks:

The present species has a close resemblance to *multiguttata* (Walker) as far its wing maculation and general coloration is concerned, but distinct from it with regard to venation of forewing. The new species is unique in having asymmetrical valvae, flap like expansions of vinculum and different juxta in its male genitalia.

Etymology:

The nomenclature of this species is after the name of Mrs. Nirmal Kaur, wife of my esteemed supervisor.

***Spilarctia himachalensis* n. sp.**

Head with vertex covered with whitish buff scales; frons furnished with pale orange scales. Antenna with scape studded with pale yellow scales. Eyes black. Labial palpus porrect, reaching lower level of frons; first and second segments decorated with black scales, underside fringed with yellow scales, third segment black.

Thorax clothed with white scales, meso and metathorax with black spots; collar dressed with whitish buff scales, spotted with black; tegula white, bearing black spots. Forewing with ground colour white, costal edge black up to middle; a basal black spot; three subbasal black spots becoming heavier towards costa; an antemedial series of five spots, those below cell and vein 1A placed outwards; a medial series of six spots, strongly excurved at lower margin of cell; two spots on inner side and one on outer side of discocellulars; two postmedial series of spots, first of nine spots, excurved below costa then strongly incurved below M_3, second of eleven spots, incurved below vein Cu_1; a marginal series of six spots; submarginal series present from apex to vein Cu_1; underside maculation heavier, inner area suffused with fuscous; veins R_2–R_5 stalked from upper angle of cell; M_2 originating from well above lower angle of cell; Cu_1 from

well before lower angle; Cu_2 beyond two-thirds of cell. Hindwing with ground colour pale orange; antemedial spots on costa and in cell; postmedial spots one on costa and below vein Sc + R1; three discoidal black spots; submarginal series of paired spots on each side of veins R_5, M_2, Cu_2 and 2A; marginal series of paired spots from veins M_1 to M_3, then single spots on Cu_1 and Cu_2; in male, post medial points below vein Cu_1 and Cu_2; veins Rs and M_1 arising from upper angle of cell; M_2 originating from well above lower angle of cell; M_3 and Cu_1 from lower angle of cell; Cu_2 from two-thirds of cell. Legs dressed with black scales, fore coxae decorated with orange yellow scales on underside; hind tibia ringed with yellow scales; tibial spurs almost of equal length.

Abdomen furnished with orange yellow scales, underside with pale yellow scales; dorsal, lateral, sublateral series of black spots prominent.

Male genitalia

Uncus well developed, narrow at base, broad and swollen in middle, triangular distally, slightly curved, tip rounded, from lateral side tip appears pointed, a transparent oval medial portion visible from dorsal and ventral side; acrotergite well developed; fenestrula absent; tegumen long, strongly sclerotized, longer than vinculum; vinculum broad V-shaped; saccus small. Valva simple, broad along two-thirds of its length, then one-third part narrow; costa slightly defined; sacculus narrow, with a slight narrow projection at distal end; cucullus and valvula fused into apical bifid projection; juxta well developed, broad and rounded at base, well sclerotized. Aedeagus long, slender, tip rounded, both of its walls equally sclerotized; vesica armed with congregations of denticles and spines at distal end, twelve of which are large, two small and one medium sized.

Female genitalia

Corpus bursae membranous and rounded; ductus bursae strongly sclerotized and coiled anteriorly, broad posteriorly; an accessory sac present; anterior apophyses short and narrow, apices blunt; posterior apophyses long with their apices slightly thick at base, then narrowing towards pointed tip; papilla analis rounded, fringed with micro and macro setae.

Wing expanse (half):	Male	:	19 mm
	Female	:	19 mm

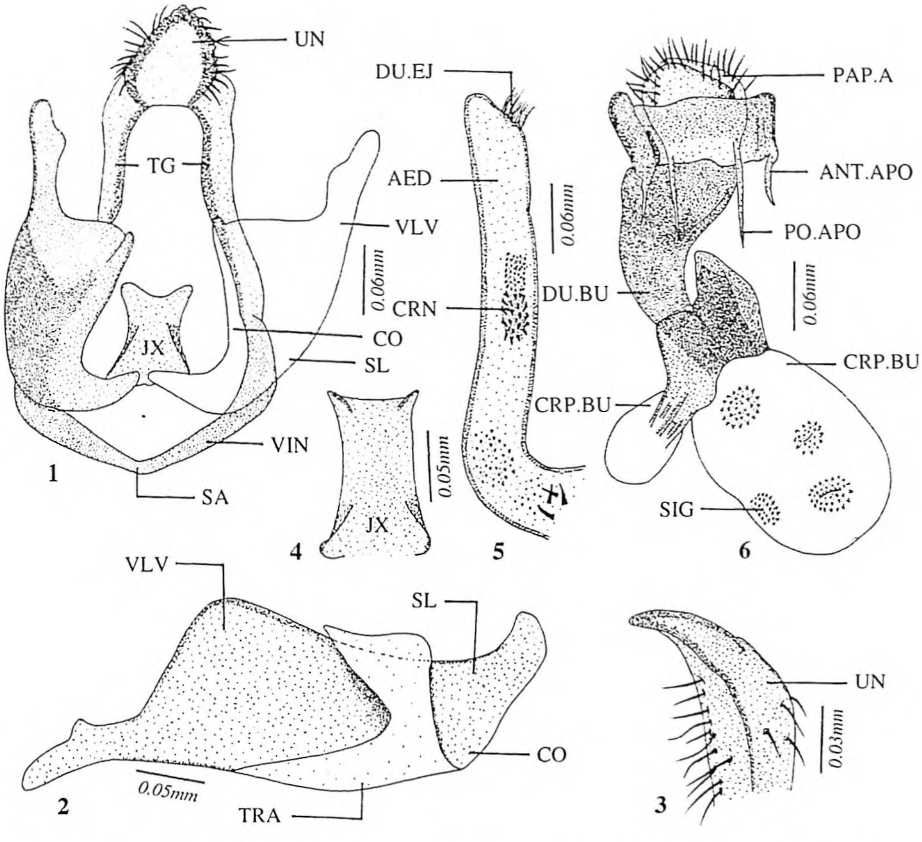
Material examined

Holotype: Himachal Pradesh: Solan, Nauni, 900 m, 01.viii.1994, 1♂.

Allotype: Himachal Pradesh: Kalpa, 3000 m, 02.vii.1995, 1♀.

Paratype: Himachal Pradesh: Solan, 1340 m, 06.vii.1991, 1♂, Nauni, 900 m, 01.viii.1994, 1♀; 02.viii.1994, 2♂♂.

PLATE NO. I



FIGURES. 1–5: Male genitalia of *Spilarctia multiguttata* (Walker); 6. Female genitalia of *Spilarctia multiguttata* (Walker).

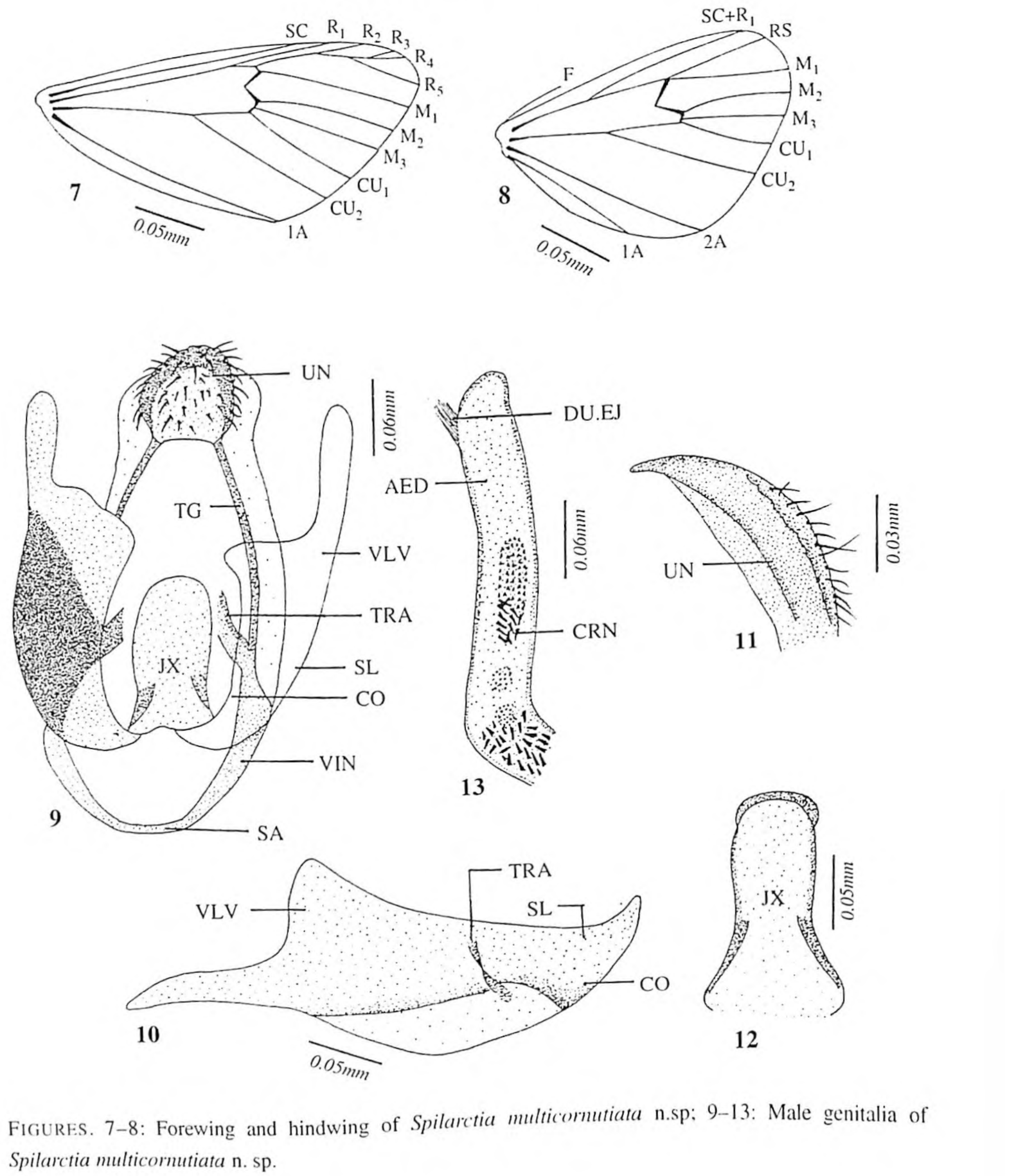
Remarks:

As many as six representatives of *himachalensis* were collected from above mentioned localities of Himachal Pradesh. This species is a close relative of another new species i.e., *nirmalae* with regard to origin of its veins R_2–R_5 in forewing and general maculation. It differs from *nirmalae* with respect to larger alar expanse, symmetrical valvae, simple vinculum and a distinct saccular projection.

Etymology

This species has been after the State name of its topotype.

PLATE NO. II

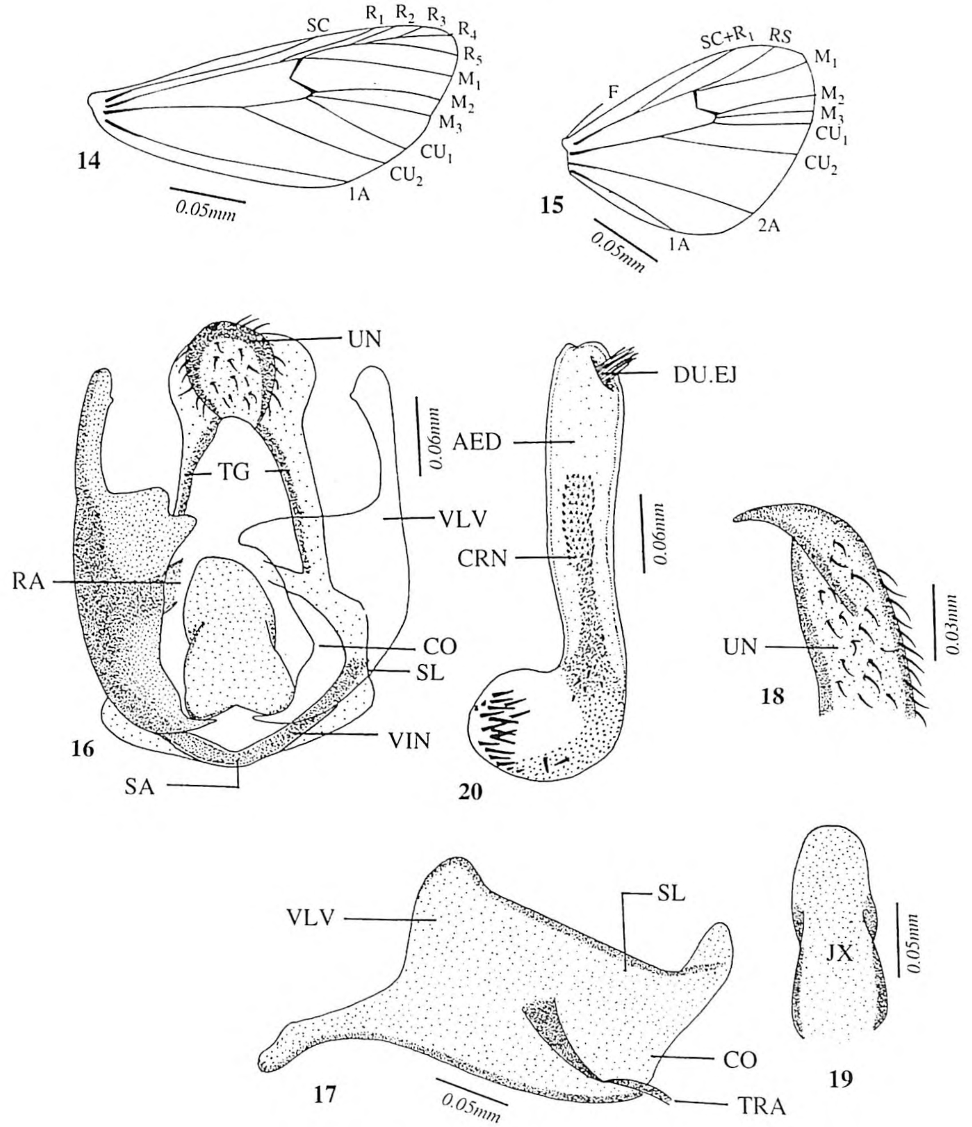


FIGURES. 7–8: Forewing and hindwing of *Spilarctia multicornutiata* n.sp; 9–13: Male genitalia of *Spilarctia multicornutiata* n. sp.

Spilarctia valvata **n. sp.**

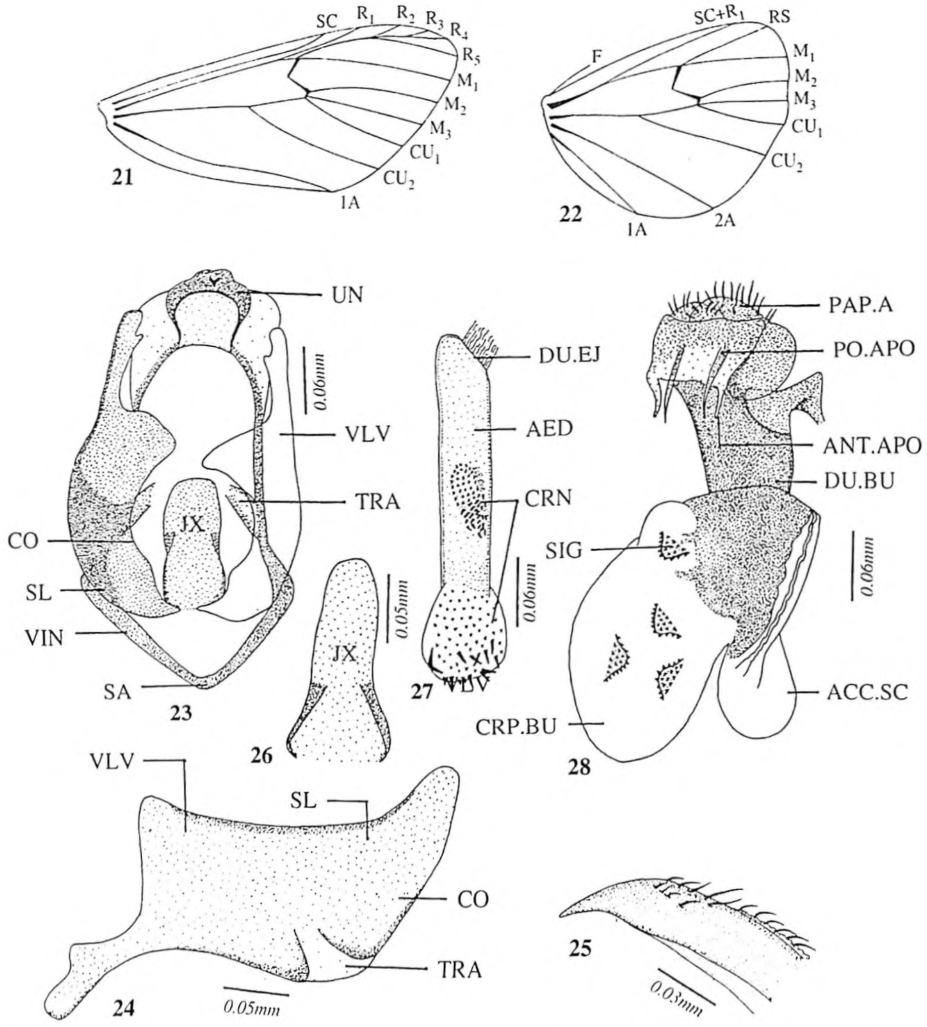
Head with vertex covered with whitish buff scales; frons furnished with yellow scales. Antenna with scape studded with pale yellow scales. Eyes black. Labial palpus porrect,

PLATE NO. III



FIGURES. 14–15: Forewing and hindwing of *Spilarctia nirmalae* n.sp.; 16–20: Male genitalia of *Spilarctia nirmalae* n. sp.

PLATE NO. IV

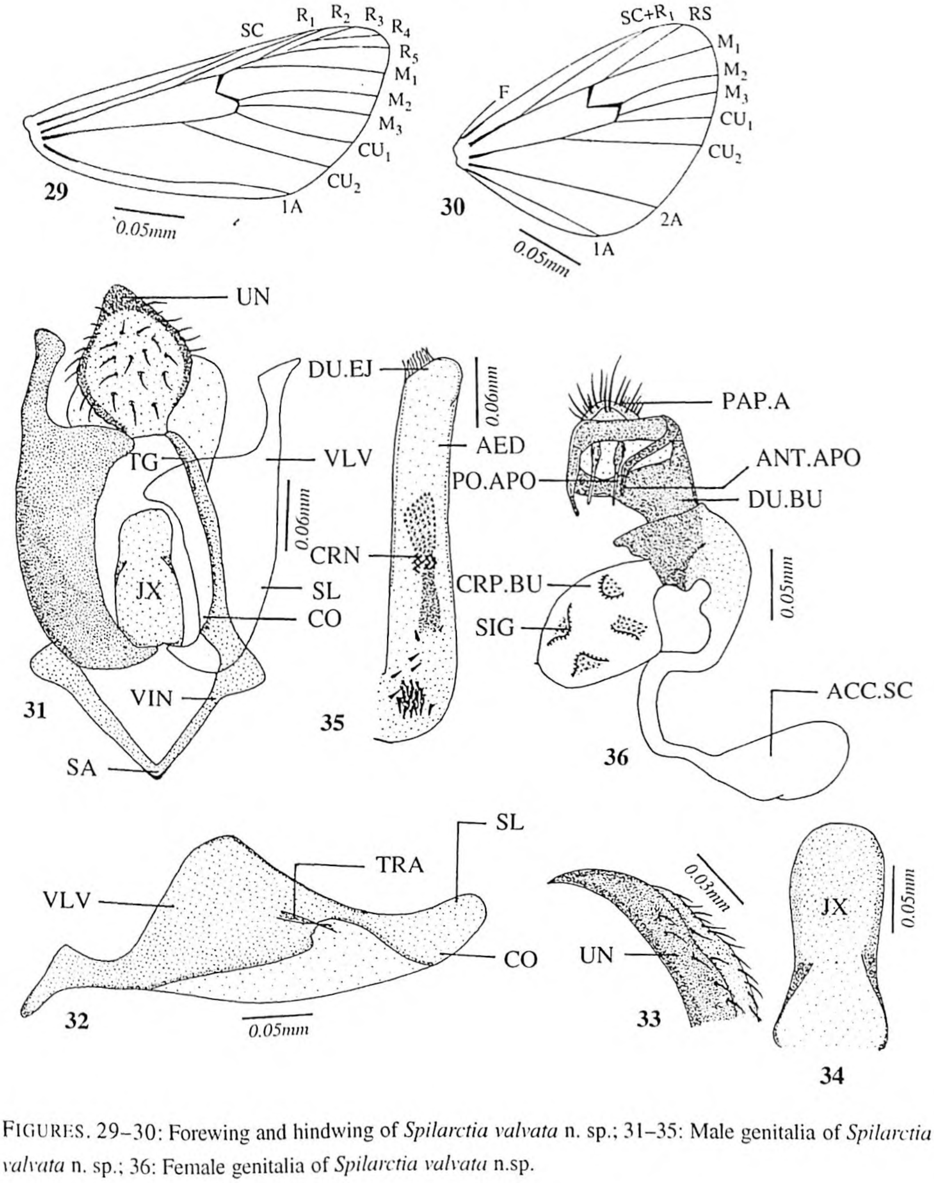


FIGURES. 21–22: Forewing and hindwing of *Spilarctia himachalensis* n. sp. 23–27: Male genitalia of *Spilarctia himachalensis* n. sp.; Figure 28. Female genitalia of *Spilarctia himachalensis* n.sp.

reaching lower level of frons; all segments decorated with black scales, underside fringed with yellow scales.

Thorax and tegula decorated with white scales, spotted with black spots; collar dressed with pale yellow scales, spotted with small black spots. Forewing with ground colour white, a basal black spot; costal edge black towards base; two subbasal black spots; an antemedial series of five spots, those below cell and vein 1A placed outwards;

PLATE NO. IV



FIGURES. 29–30: Forewing and hindwing of *Spilarctia valvata* n. sp.; 31–35: Male genitalia of *Spilarctia valvata* n. sp.; 36: Female genitalia of *Spilarctia valvata* n.sp.

a medial series of six spots, one spot in cell and three spots around discocellulars; two postmedial series of spots, first of nine spots, excurved below costa then strongly incurved below M_3, second of eleven spots, those below M_1 reduced, those below R_5

and on and below M_1 placed inwards; submarginal series of paired spots on each side of veins from apex to Cu_1; six marginal spots present; maculation heavier on underside and suffused with fuscous except apical area; veins R_2-R_5 stalked from upper angle of cell; M_2 originating from well above lower angle of cell; Cu_1 from well before lower angle; Cu_2 beyond three-fourths of cell. Hindwing with ground colour yellow; antemedial black spots, one on costa, another in cell; postmedial fuscous spots on costa and one below vein Sc + R1; spots on both sides of discocellulars; submarginal spots on veins R_5, M_2 and below 2A; marginal spots below veins M_1 to M_2, point like spots below M_3 & Cu_1; fringe yellow; veins Rs and M_1 shortly stalked from upper angle of cell; M_2 originating from well above lower angle of cell; Cu_1 from before lower angle of cell; Cu_2 from well beyond middle of cell. Legs clothed with black scales, fore coxae stripped with yellow; femora fringed with pale yellow scales on underside; tibia streaked with yellow on inner side; outer tibial spurs more than half length of inner ones.

Abdomen furnished with yellow scales, however, underside clothed with pale yellow scales; a dorsal, lateral and sublateral series of black spots prominent.

Male genitalia

Uncus well developed, broad in middle, narrowing towards blunt tip, appears pointed from lateral side, dorsally setosed; acrotergite covering lower half of uncus; fenestrula absent; tegumen narrow, well sclerotized, slightly longer than vinculum; vinculum broad V-shaped, produced outwardly towards tegumen; saccus prominent pointing backwards. Valva simple and broad with narrow costa; sacculus small, with a rounded projection; cucullus and valvula fused into a hammer-shaped projection; juxta well developed, dilated in middle; tip rounded, transtilla prominent and semi-sclerotized. Aedeagus long, narrow above, tip rounded, distal end broad; vesica armed with many congregations of spines and denticles; prominent long, sclerotized and uncountable spines at distal end.

Female genitalia

Corpus bursae membranous and rounded; two pairs of semi-circular serrated signa present; ductus bursae highly sclerotized; an accessory sac present; anterior apophyses shorter than posterior apophyses, with their apices blunt, however, posterior ones dilated at base, tips rounded; papilla analis broad and triangular fringed with fine small and large setae.

Wing expanse (half):	Male :	20 mm
	Female:	20 mm

Material examined

Holotype: Himachal Pradesh: Solan, Nauni, 900 m, 01.viii.1994, 1♂.

Allotype: Uttaranchal: Dehradun, 700 m, 14.ix.1991, 1♀.

Paratype: Himachal Pradesh: Solan, Nauni, 900 m, 01.viii.1994, 1♂.

Remarks:

The species under reference is allied to another new species *himachalensis* on the basis of its wing expanse, maculation, pattern and a distinct saccular projection. However, it is distinct from *himachalensis* with respect to characters like venation of hindwing, shape of valva and vinculum, armature of aedeagus in male genitalia and corpus bursae, apices of apophyses of female genitalia.

Etymology:

The name of the species pertains to its distinct valva in male genitalia.

Key to the species of *multiguttata* complex of genus *Spilarctia* Butler

1. Forewing with veins R_2–R_5 stalked from before upper angle of cell 2

   ..... Forewing with veins R_2-R_5 stalked from before upper angle of cell 3

2. Collar and tegula clothed with white scales; forewing with four sub basal black spots and medial series of seven spots; male genitalia with acrotergite covering lower half of uncus; valva with a triangular projection near distal end; aedeagus long with two congregations of small spines and denticles and four large spines at distal end .... *multiguttata* (Walker)
   Collar and tegula clothed with pale yellow scales; forewing with three subbasal black spots and medial series of six spots; male genitalia with acrotergite covering almost three-fourths of lower portion of uncus; valva without any projection near distal end; aedeagus of moderate length, with numerous spines at distal end *multicornutiata* n.sp.

3. Tegula dressed with white scales; male genitalia with valva symmetrical, saccular margin rounded, a distinct projection near distal end; vinculum without flap like expansion 4
   .... Tegula dressed with pale yellow scales; male genitalia with asymmetrical valva, saccular margin with rounded projection in left valva and bilobed in right valva; vinculum with flap like expansions .... *nirmalae* n. sp.

4. Hindwing with veins Rs and M_1 originating from upper angle of cell, Cu_1 from lower angle of cell; male genitalia with valva having distal end bifid; vinculum without lateral expansions; aedeagus short, vesica armed with fifteen distinct spines; female genitalia with corpus bursae rather large; anterior apophyses with blunt apices, posterior apophyses with pointed tips .... *himachalensis* n.sp.

5. ...... Hindwing with veins Rs and M_1 shortly stalked from upper angle of cell, Cu_1 from before lower angle of cell; male genitalia with valva having distal end hammer shaped; vinculum with lateral expansions; aedeagus of moderate size, curved at distal end, vesica armed with numerous spines; female genitalia with corpus bursae small; both pair of apophyses with their apices rounded ....
   .... *valvata* n.sp.

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A new species of *Aprostocetus* Westwood (Hymenoptera: Eulophidae) parasitic on *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) from India

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ABSTRACT: A new species *viz. Aprostocetus obtusae* Narendran and David sp. nov. parasitic on *Melanagromyza obtusa* (Malloch) a major pest of pulses in India is described and its differences from its closely resembling species are provided.

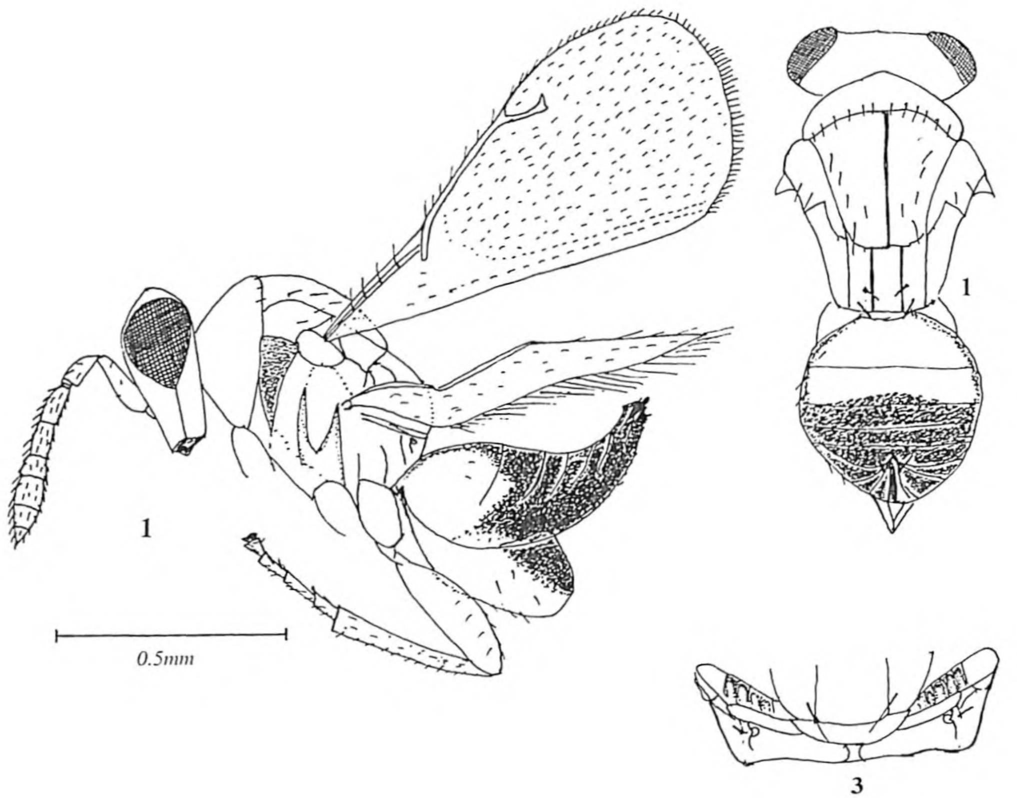
KEYWORDS: New species, Eulophidae, *Aprostocetus*, India

INTRODUCTION

Pulses form an important part of Indian dietary. They are an important source of protein, are essential adjuncts to a predominantly cereal-based diet and enhance the biological value of the protein consumed (Ramanujam, 1980). The pod-fly *Melanagromyza obtusa* (Malloch) is a serious pest of pulses like redgram, soyabean, cowpea, and pegeonpea. Several chalcidoid parasitoids are known to attack this notorious pest. They are: *Diglyphus funicularis* Khan, *Diglyphus mandibularis* Khan, *Euderus agromyzae*, Gangrade, *Euderus lividus* (Ashmead), *Eupelmus* sp. *Eurytoma melanagromyzae* Narendran, *Plutarchia* sp., *Ormyrus orientalis* Walker, *Monodontomerus* sp., *Pseudotorymus* sp. and *Microdontomerus* sp. (Noyes, 2003; Narendran, 1994, 1999; Khan, 1985; Gangrade, 1961; Ahmad, 1940). In this paper we describe a new species of Eulophidae parasitic on *Melanagromyza obtusa* from India. The holotype is deposited at ZSIK.

Abbreviations used: F1-3 = Funicular segments 1–3, MV = Marginal vein, OOL = Ocellocular line, PMV = postmarginal vein, POL = Postocellar line, SMV =

*Corresponding author



FIGURES 1–3: *Aprostocetus obtusae* Narendran and David sp. nov. Female. Fig. 1. Body profile; Fig. 2. Part of body in doral view; Fig. 3. Propodeum.

submarginal vein, STV = stigmal vein, ZSIK = Western Ghat Regional station, Zoological Survey of India, Calicut, India.

Aprostocetus obtusae Narendran and David sp. nov. (Figs. 1–3)

Holotype: Female

Length 1.17 mm. Black (without metallic refringence) with the following parts as follows: antenna pale brown with scape and pedicel pale yellow; tegula pale brownish yellow, fore coxa black with other segments of fore leg pale yellow, apex of fourth tarsal segment and pretarsus darker, mid coxa dark brown, remaining segments of mid legs as in fore leg; hind coxa dark brown with pale apex, remaining segments of hind leg as in mid leg; first and second gasteral tergites pale brownish yellow, hypopygium except apical dorsal darker part pale brownish yellow, remaining parts of gaster black; forewing hyaline with veins brown; pubescence pale yellow.

Head

Collapsing, width in anterior view subequal to its length, a little less than width of mesosoma in dorsal view; nearly smooth; lateral ocellus slightly nearer to median ocellus than to eye; POL:OOL = 6.4; eye not subcircular, asetose; gena not convex; male sulcus simple, not arcuate; toruli distinctly below lower ocular line; lower clypeal margin bilobate; antennal flagellum plus pedicel 0.81x breadth of head, scape slender, distinctly shorter than eye, to reaching vertex; pedicel 2x as long as wide, subequal to F1 in length, slightly longer than F2, clava 3x as long as F3; flagellum slightly thickening towards apex, 2.43x as long as scape, with two antelli, clava apparently two segmented with a pointed apex, specula not very distinct.

Mesosoma

1.24x as long as broad, with longitudinal striation on mesocutum; median lobe of mesoscutum with a median groove, with 5 adnotaular setae on either side, one of them situated slightly away towards innerside from the longitudinal row, scutellum 1.54x as broad as long, convex with pairs of setae, anterior ones slightly behind middle, submedian grooves parallel, median area 2.16x as long as broad; slightly broader than area between submedian and sublateral lines on either side; dorsellum 6x as broad as long. Propodeum as long as dorsellum with a broad median carina, submedian areas faintly reticulate; plical carina indistinct; spiracle almost touching metanotum, its rim not fully exposed, partly covered by overlapping propodeaum. Hind coxa weakly reticulate on its dorsolateral surface. Forewing 2.2x as long as wide, exceeding apex of gaster. Relative lengths of costal cell 30; MV 29; STV 9; PMV hardly distinct SMV with 4 dorsal setae; speculum closed behind by cubital line of setae.

Metasoma

Little shorter than mesosoma; 1.27x as wide as maximum width of mid lobe of mesoscutum, apex strongly tilted upwards; one of the cercal setae longer than others.

Male

Similar to female except for the following characters: all funicular segments and clava with longer hairs; first funicular segment distinctly shorter than pedicel; claval apex with a narrow short specula. Gaster not as broad as that of female, about 0.85x as broad as maximum width of middle of mesoscutum; metasoma slightly longer than mesosoma.

Host

Parasitic on *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae).

Distribution

India (Chennai).

Material examined

Holotype: Female. India, Tamil Nadu, Chennai (134°5′N 80°16′E), 3.iv.2004. ex. *Melanagromyza obtusa*. Selvaraj (ZSIK)

Etymology

The species name is after the host *Melanagromyza obtusa* (Malloch).

Paratype

1 male same data as for holotype.

Remarks

This species comes near *Aprostocetus bangaloricus* Narendran (Hayat *et al.*, 2003) in general appearance but differs from it in the following characters.

	Aprostocetus obtusae Narendran and David sp. nov.	*Aprostocetus bangaloricus* Narendran
1.	Head width less than width of mesosoma	Head width subequal to width of mesosoma
2.	Antennal toruli distinctly below lower ocular line	Antennal toruli above lower ocular line
3.	Flagellum + pedicel 0.81x width of head	Flagellum + pedicel subequal to width of head
4.	Pedicel slightly longer than F2	Pedicel slightly shorter than F2
5.	Clava 3x as long as F3	Clava 2.4x length of F3
6.	Clava 2.43x as long as scape	Clava 2.5x as long as scape
7.	Mesosoma 1.24x as long as wide	Mesosoma 1.5x as long as wide
8.	Mesoscutum with 5 adnotaular setae with one seta on inner side away from the row on either side	Mesocutum with 4 dorsal setae in a longitudinal row, without an inner seta on either side
9.	Median area between submedian grooves of scutellum 2.16x as long as wide	Median area between submedian grooves of scutellum 1.5x as long as wide
10.	Dorsellum 6x as wide as long	Dorsellum 4x as wide as long
11.	Propodeal spiracle with rim not fully exposed	Propodeal spiracle with rim fully exposed
12.	MV as long as or a trifle shorter than costal cell	MV 1.52x as long as costal cell
13.	Gaster never longer than mesosoma	Gaster of little longer than mesosoma
14.	Apex of gaster titled up in female	Apex of gaster not tilted up in female
15.	Width of gaster 1.36x length of median lobe of mesoscutum	Width of gaster 1.25x length of median lobe of mesoscutum

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A new species of Monotomidae from Nagaland, India (Coleoptera: Cucujoidea)

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ABSTRACT: A new monotomid species, *Tarunius chakesang* is described from the northeast Indian State of Nagaland and its distinction from other lone species of the genus, *T. punctatus* Sengupta is given.

KEYWORDS: Coleoptera, Monotomidae, *Tarunius* Sengupta, New species, Nagaland

INTRODUCTION

The Monotomidae, otherwise referred to as Rhizophagidae, are a moderately small family containing about 250 species and are represented in all major biogeographic regions of the world. The concept of this family suffered from changes since Redtenbacher (1845) until Crowson (1955) defined the group. A major taxonomic review of the family, including description of 3 new genera, was provided by Sengupta (1988). Later, Pal (1996) described one new genus from Arunachal Pradesh, India, and by now about 30 species under 12 genera have been recorded from India. Earlier, Sengupta (1977) described the monotypic genus, *Tarunius* from Sikkim. During a fieldwork in Nagaland the beetles of Monotomidae were collected by the author from the woodlands and vegetation. One new species of *Tarunius* Sengupta in the collection is described in this paper.

Family: MONOTOMIDAE

Subfamily: MONOTOMINAE

Genus *Tarunius* Sengupta

Tarunius Sengupta, 1977, *Orient. Ins.* **11** (4): 532 (Type: *Tarunius punctatus* Sengupta, by original designation and monotypy).

Diagnosis

Elongated, moderately depressed, glabrous; head with partly exposed mandibles, non-projecting eyes, well developed tempora, 10-segmented antenna with 1-segmented club; elongated pronotum medially foveolate, serrated margins; front coxal cavities broadly closed behind, mesocoxal cavities open, hind coxae rather closely situated; intercoxal process of first abdominal ventrite moderately narrow and rounded apically; without coxal (femoral) lines on metasternum and abdominal ventrite; elytra striate-punctate, epipleura narrow and short.

Tarunius chakesang **sp. nov.**

General appearance (Fig. 1) elongate, subdepressed, deep reddish-brown, dorsal puncturation rather coarse, cuticle rather shiny and glabrous, apical tergite of abdomen exposed.

Head (between apex of clypeus and hind part of tempora) slightly transverse, widest across eyes, eyes rather small, shorter than one-fourth as long as head, finely facetted, tempora well developed and about 1.5× as long as eyes, sides of head above antennal bases somewhat raised; puncturation on vertex rather coarse (punctures separated by 0.75–4.0 diameter), becoming gradually finer on frons and clypeus and above antennal bases; clypeus emarginate; posterior border of vertex and neck constriction prominent. Antenna slightly longer than head, scape moderately large and slightly elongate, pedicel shorter and narrower than scape, segment 3 little elongate, segments 4–9 shorter, subequal and transverse, segment 10 (club) elongate and about as long as preceding three segments.

Pronotum elongate (1.2 : 1.0), somewhat parallel-sides and about as wide as head, front angles obtuse, hind angles rounded and not well marked, sides and base finely bordered, sides finely serrulate; front margin rounded, finely bordered by striate punctures; disc with a shallow median elongate fovea which broadened and more depressed posterad; puncturation on disc coarse and rather dense (punctures separated by 1.0–1.8 diameter), becoming finer anterad and posterad, large part of median fovea impunctate.

Scutellum transverse, glabrous and apical margin rounded.

Elytra about 1.8x as long as broad, sides feebly arched, apex of each elytron slightly rounded, small punctures in eight regular rows along fine impressed strial lines, interstices not raised or ribbed, pygidium with coarse and dense punctures.

On ventral side prosternum with feeble transverse striations and moderately coarse and sparse punctures; metasternum medially impunctate, rather coarse punctures on sides; abdomen with fine and sparse punctures except the last ventrite which bears dense punctures.

Measurements of holotype

Total length (apex of mandible to tip of pygidium) 4.0 mm, width of head across eyes 0.80 mm, length of antenna 0.81 mm, length and width of prothorax 0.90 mm and 0.80 mm, length and width of elytra 1.62 mm and 0.88 mm.

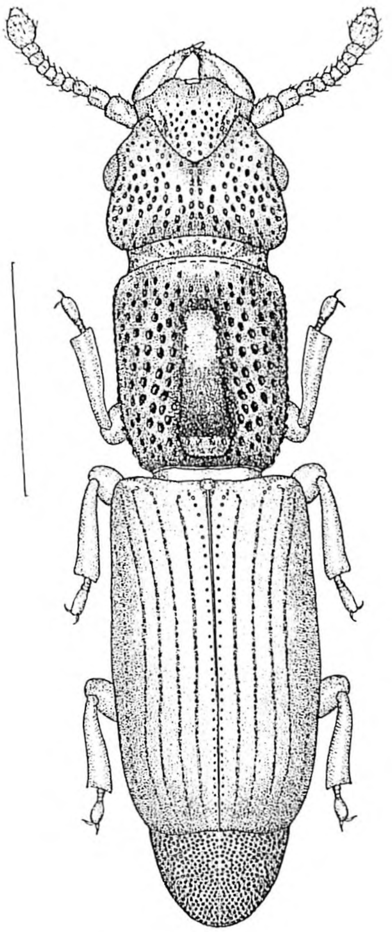

FIGURE 1. *Tarunius chakesang*, sp. nov.; Dorsal view (scale = 1.0 mm).

Holotype ♀, India

Nagaland, Phek District, Sürhoba, 1250 m., 12 km. O - Phek, 23.x.1998, T. K. Pal and party, ex. beating bush (Zoological Survey of India, Kolkata).

Etymology

The species is named after 'Chakesang', the sect of the Naga tribe that live in Phek District of Nagaland, where the species has been found.

Remarks

This species differs from other lone species of the genus, *Tarunius punctatus* Sengupta by its shorter eyes (0.23x head length vs. 0.48x head length in *punctatus*), longer

tempora (1.56x ocular length vs. 0.5x ocular length in *punctatus*); a considerable portion of the median elongate fovea of pronotum impunctate and fovea broadened posterad; puncturation on vertex and pronotal disc sparser, less uniformly distributed than in *punctatus* and elytral punctures distinctly finer; and species longer in size (4.0 mm vs. 2.35 mm in *punctatus*).

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Effect of azadirachtin on total free amino acids in the haemolymph of larva of *Corcyra cephalonica* (ST.)

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ABSTRACT: Azadirachtin caused concentration dependent quantitative variations in total free amino acids in haemolymph of *Corcyra cephalonica* larva. After 24 h of treatment there was significant decrease but at 48, 72 and 96 hours the total free amino acids level increased.

KEYWORDS: Azadirachtin, amino acids, haemolymph, *Corcyra cephalonica* (ST.)

Amino acids are important constituent of insect body. These amino acids occur as free amino acids having high concentration in insect haemolymph. They vary widely among species. The free amino acid ranges from 293 to 2430 mg/100 ml (Duchateau and Florkin, 1958). The high concentration of free amino acids is believed to play an important role in osmoregulation (Bishop *et al.*, 1926; Beadle and Shaw, 1950) energy production for flight and coccon construction (Wyatt, 1961). It is also important for buffering of blood to some extent with predominant function of units for protein synthesis (Buck, 1953).

It is observed that in *Corcyra* some plant extract showed insecticidal activity (Chauhan *et al.*, 1987). In recent years sufficient evidence has accumulated and it clearly indicates that any biochemical change due to physical or chemical factor is reflected by a change in the chemical composition of haemolymph. The amino acid alterations in the haemolymph of insect many enlight on the control of *Corcyra* which is possible by treating them with plant products. In the present investigation the effect of azadirchtin on free amino acids in the haemolymph of the last instar larva of *Corcyra cephalonica* (ST.) was studied.

A rich standard culture of *Corcyra* was maintained in the laboratory on a normal dietary medium composed of coarsely ground Jawar mixed with 5% (W/W) powdered yeast in large glass containers (150 mm diameter, 200 mm height at 26 ± 1 °C and 93 ± 5% R.H.).

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TABLE 1. Azadirchtin induced changes in total free amino acid level in haemolymph of the larva of *Corcyra cephalonica* (ST.)

Hours of treatment	Total free amino acids mg/gm of haemolymph			
	Control (untreated larvae)	10% Neemark 90.92	15% Neemark	20% Neemark
0	94.08 ±3.28	90.92^{NS} ±1.62 (3.36)	61.85* ±2.72 (35.1622)	39.46 ±3.63 (58.55)
24	54.49 ±1.42	32.84* ±1.73 (39.74)	27.97* ±1.63 (48.68)	27.48* ±1.52 (49.58)
48	75.30 ±4.24	78.17^{NS} ±2.12 (−3.58)	87.35* ±2.31 (−15.54)	91.31* ±3.18 (−20.85)
72	89.12 ±3.51	108.17* ±2.53 (−21.18)	111.81 ±1.82 (−24.54)	115.05* ±1.88 (29.03)
96	125.43 ±3.46	140.82* ±4.61 (−11.61)	145.63* ±3.63 (−16.06)	148.53* ±2.64 (−18.42)

Each value is the mean of five observations ±S.D.; Values sin parentheses indicates % variation over control.; Values are significant at $P < 1^*$ on N.S. not significant.

Commercially available neem insecticide, Neemark containing azadirachtin was used in the studies. The normal dietary medium mixed with varying concentration of insecticide (20%, 15% and 10%) was offered to the test insect as food. In each container 100 larvae were allowed to feed. Similarly controlled as well as normal dietary medium with 50 larvae each were maintained.

After the treatment the larvae from each experimental set were taken out separately from treated as well as controlled dietary media at '0, 24, 48, 72 and 96 h and treatment.

Haemolymph from the larvae was obtained by making a small puncture by means of a sharp needle at the dorsolateral side of the prothoracic segment and drawing the blood, easily oozing out through this puncture into a previously measured time glass capillary tube which was again measured on monopan balance (Dhona) and was used immediately for the analysis. Care was taken not to injure the inner organs specially the digestive tract. Estimation of total free amino acids was carried out according to the method by Spies (1957), using glycine solution as standard. 50 μl of haemolymph was collected, measured and its volume was made to 0.1 ml, by adding 96% ethanol. The 0.1 ml of distilled water and 2.0 ml of ninehydrin reagent were added and mixed thoroughly. The reaction mixture was kept in boiling water bath for exactly

15 minutes. After cooling 2.0 ml of 50% ethanol was added to each tube. A violet colour developed.

The absorbancy was measured and compared with a set of aqueous glycine solution of varying concentration (10 μg/ml). Results were expressed as mg/gm of haemolymph. The total free amino acids concentration in the haemolymph of control larvae decreased continuously from '0' to 48 h followed by an increase till 96 h (Table 1).

The total free amino acids in the haemolymph at 24 h of treatment showed decrease than that of the untreated larvae. This decrease may be due to increased neuromuscular activity of treated larvae which resulted in higher demands for energy. Due to it there is increase in the a rate of entry of free amino acids (FAA) in tricaboxylic acid cycle (TCA) and yet oxidized. It results that the total FAA pool of haemolymph is reduced drastically. This view is also supported by Pandey and Mathur (1990). On the other hand at 48 hours, 72 hours and 96 hours of treatment there was increase in the FAA level of haemolymph.

This increase may be either due to low food intake, reduction in protein synthesis or higher mobilization of proteins. Ayyangar and Rao (1990) observed increased FAA level after azadirachtin injection in *Spodoptera litura*. Krishnayya and Rao (1995) studied that there is enhancement in total FAA level of *Helicoverpa armigera* due to plumbagin. Tiwari and Bhatt (1996) reported increased FAA level in *haemolymph armigera* due to plumbagin. Tiwari and Bhatt (1996) reported increased FAA level in haemolymph of *Corcyra* larvae due to methoxychlor and dimethoate treatment. It can be concluded that the decline at early stage was due to higher metabolic activity and imbalance between the rates of anabolism and catabolism in the azadirachtin treated larvae. The rise of total FAA level at later stages may be due to protein depletion and/or inhibition of amino acid incorporation into proteins.

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ENTOMON **30(3)**: 235–236 (2005)
Short Communication No. ent.30307

Halyomorpha sp. nr. *picus* (Fabricius) (Hemiptera: Pentatomidae) and *Pagria signata* (Motschulsky) (Coleoptera: Chrysomelidae), two new pests of vegetable cowpea

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ABSTRACT: Incidence of two new pests *viz., Halyomorpha* sp. nr. *picus* (Fabricius) and *Pagria signata* (Motschulsky) in vegetable cowpea (*Vigna unguiculata* ssp. *sesquipedalis* (L)Verdcourt) is reported from Kerala. The pentatomid bug, *Halyomorpha* sp. nr. *picus* sucks sap from tender vines and pods of cowpea. The chrysomelid beetle, *P. signata* produces numerous shot holes in the leaves. A fungus infecting *P. signata* in the field was isolated and identified as *Mucor hiemalis f hiemalis* (Wehmer).

KEYWORDS: Vegetable cowpea, *Halyomorpha* sp. nr. *picus*, , *Pagria signata*, entomopathogen, *Mucor hiemalis f hiemalis*

In a survey conducted in Thiruvananthapuram and Kollam districts of Kerala during 2004, a pentatomid bug, *Halyomorpha* sp. nr. *picus* (Fabricius) and the Oriental bean beetle, *Pagria signata* (Motschulsky) were found infesting vegetable cowpea *Vigna unguiculata* ssp. *sesquipedalis* (L) Verdcourt. These insects were recorded first time as pests of vegetable cowpea in India.

Halyomorpha sp. nr. *picus*

The adult bugs were yellowish brown. The abdomen showed alternating white and black patches in adults. It laid eggs on the under surface of the leaves in clusters of 30–35. The newly hatched nymphs were yellow with brown thoracic nota and three transverse brownish abdominal patches. The second to fifth instar nymphs were black in colour. The nymphs reached adulthood within 43–45 days.

The nymphal stages of the bug were found to suck sap from the tender vines and pods of cowpea. The occurrence of related species *viz., Halyomorpha marmorea* F. in arecanut in Kerala (Nair, 1999) and *Halyomorpha halys* (Stal) as a polyphagous pest

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in Asia and America (Hoebeke and Carter, 2003) was reported earlier. *H. picus* was reported sucking sap from the vegetative buds and inflorescence of Vanilla (Prakash and Sudharshan, 2002).

Pagria signata (Motschulsky)

The yellowish brown adult beetle has a black spot on each elytron. The margins of the elytra were brownish. The adult feeding produced numerous (up to 640) shot holes in the leaf, which reduced the photosynthetic area. Initially feeding appeared on the mature leaves and it subsequently spread to young leaves. Yein (1983) mentioned *P. signata* as a pest of black gram. Under field situations the pathogenic fungus *Mucor hiemalis f hiemalis* (Wehmer) was found to cause mortality of the adult beetles.

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ENTOMON **30(3)**: 237–241 (2005)
Short Communication No. ent.30308

Anathamna neospermatophaga sp. nov. (Enarmoniini: Olethreutinae: Tortricidae) from Western Himalaya, India

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ABSTRACT: An illustrated account of *Anathamna neospermatophaga* sp. nov. collected from the Western Himalaya is reported in this communication including description of the wing venation and the male and female genitalia. The species can be diagnosed on the basis of characters of male genitalia, particularly of cucullus being produced into a beak-like structure and having a short and sharply bent aedeagus and the female genitalia having two unequal triangular pyramid-shaped signae. The genus is reported for the first time from India. © 2005 Association for Advancement of Entomology

KEYWORDS: Lepidoptera, Enarmoniini, *Anathamna*, Genitalia, Western Himalaya

A phenon comprising seventy-one male and nineteen female individuals broadly conform to the genus *Anathamna* Meyrick (Meyrick, 1911; Diakonoff, 1966). The genus comprises seven species i.e., *Anathamna ostracitis* Meyrick (New Guinea), *A. anthostoma* Meyrick (New Britain), *A. chionopyra* Diakonoff (New Guinea), *A. megalozona* Meyrick (Sri Lanka), *A. plana* Meyrick (Australia), *A. spermatophaga* Diakonoff and Bradley (Papua New Guinea), and *A. syringias* Meyrick (Soloman Islands) from the respective zoogeographic areas (Tuck, *pers. comm.*). After critical evaluation of various morphological characters, particularly the wing venation and genitalia, it has been analyzed that the unnamed species goes nearer to *A. spermatophaga* Diakonoff and Bradley. However, it differs from the same in having narrower soccii, the aedeagus highly angled and cucullus being narrower and beak-like in the male genitalia. The sclerotized area lateral to the ostium bursae in the female genitalia is also wanting. This is the first report of this genus from India. A detailed account of the new species is given below.

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***Anathamna neospermatophaga* sp. nov.**

Male, Female

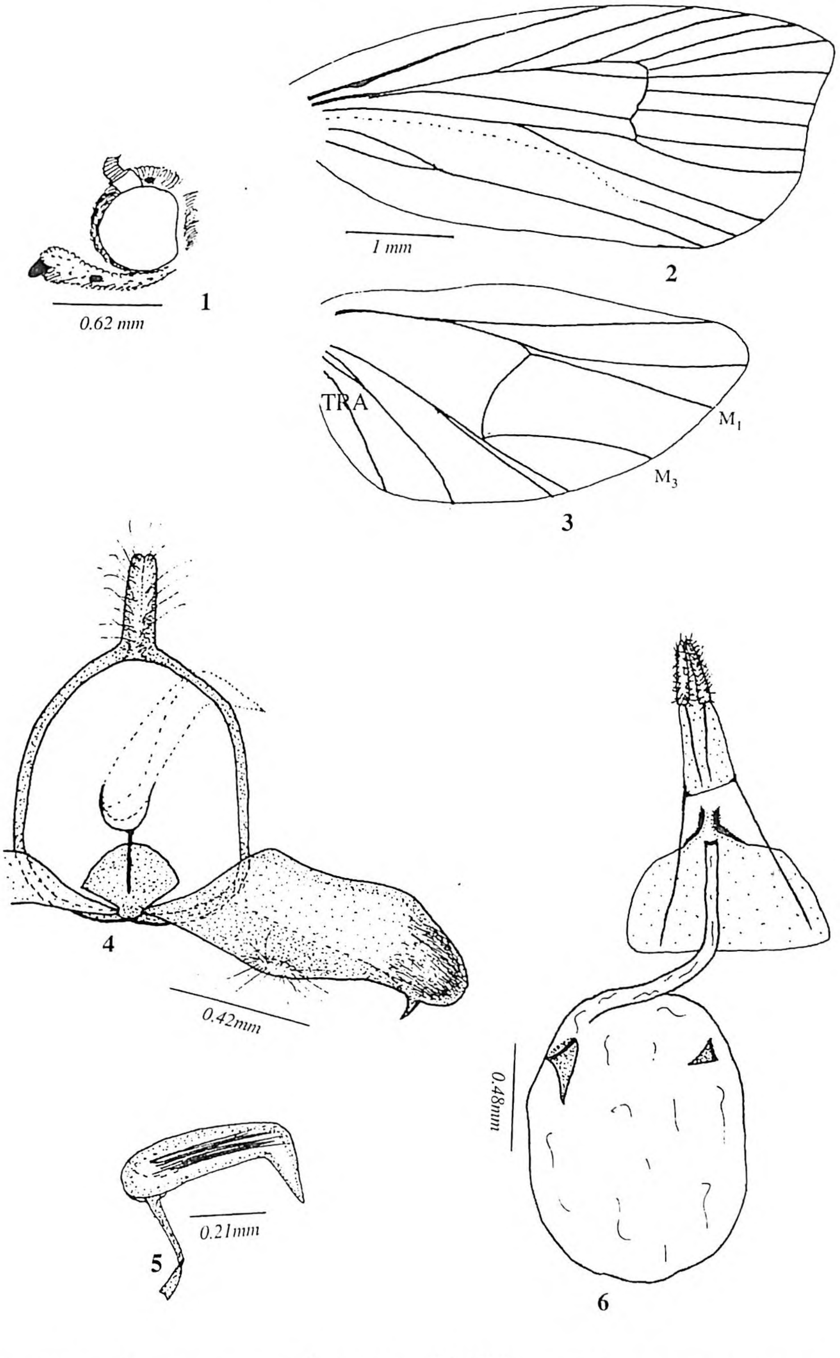
Alar expanse: 11–12 mm. Vertex dark fuscous anteriorly, light brown with a tinge of light orange posteriorly; frons dark fuscous; antenna filiform, dark fuscous; labial palpus moderate, two times diameter of eye, porrect, second segment pale ochreous with tip black, third segment minute, hardly visible, slightly drooping, black; thorax covered with dark fuscous scales mixed with light brown, with light orange tinge; forewing with costa gradually arched throughout, apex round pointed, termen oblique, gently concave above, rounded beneath, tornus obtuse, anal margin straight, throughout covered with mixed scales of dark fuscous, yellowish ochreous and light orange colour, blue violet streaks near costa and termen, basal costal strigulae ill-defined, yellowish, five post medial strigulae white, gradually increasing in size towards apex, fringes with dark fuscous cilia, mixed with light orange; hindwing quadrate, dark grey, fringes grey with dark subbasal shade; legs fuscous with yellow rings.

Wing venation (Fig. 2 and 3)

Forewing with Sc ending slightly beyond middle of costa, R_1 arising in the middle of cell, R_2 closer to R_3 than R_1, R_3 closer to R_4 than R_2, R_4 and R_5 free, R_4 arising from upper angle of cell, ending at costa, R_5 ending at termen, M_1 M_2 and M_3 almost parallel, equally distant, M_3 and CuA_1 free, CuA_1 arising from lower angle of cell, CuA_2 from posterior one-third, CuP visible only towards distal end, 1A+2A forked at base, fork small, chorda arising in the middle of R_1 and R_2, M-stem straight, ending between M_2 and M_3 slightly towards M_2; hindwing with $Sc+R_1$ ending on costal margin near apex, Rs and M_1 closely approximated at base, Rs to termen below apex, M_1 to termen, M_2 absent, M_3 and CuA_1 connate, strongly diverging distally, CuA_1 arising from lower angle of cell, CuA_2 from near lower angle, running very close to CuA_1, CuP visible only near the distal end, 1A+2A forked at base, 3A present, diverging distally.

Male genitalia (Figs. 4 and 5)

Uncus absent; socii represented by two long narrow lobes, each sparsely setosed; tuba analis membranous; tegumen very thin, high, somewhat rounded, apex with long hair; vinculum reduced, somewhat oval in outline; costa arched basally, sacculus long, broad, with a bunch of fine hair medio-ventrally; cucullus densely hairy distally, arched dorsally, rounded distally, ventrally produced into a beak-like structure; aedeagus short, broad, sharply curved subapically, abruptly pointed, vesica bearing a sheath of long deciduous cornuti; caulis band-like.



FIGURES 1–6: *Anathamna neospermatophaga* **sp. nov.**, 1. Labial palpus, 2. Forewing venation, 3. Hindwing venation, 4. Male genitalia: Ventral view, 5. Aedeagus, 6. Female genitalia: ventral view.

Female genitalia (Fig. 6)

Papillae anales flat, long, narrow, slender; sterigma with a deep incision, somewhat hairy; ostium bursae narrow; ductus bursae short, narrow; corpus bursae large, globular, with two unequal sized signae, the latter triangular, pyramid shaped.

Material examined

Holotype: Himachal Pradesh, Dist. Solan, UHF, Nauni, 1360 m, 10.ix.1998, 1♂.
Paratypes: Himachal Pradesh: Dist. Solan; UHF, Nauni, 1360 m, 10-11.ix.1998, 24♂♂, 12♀♀, 12.ix.1999, 14♂♂; Dharampur, 1500 m, 16.vii.1999, 1♂, 1♀. Dist. Sirmour; Renuka Lake, 740 m, 3.ix.1999, 1♂, 5.ix.1999, 1♀.
Uttaranchal: Dist. Dehradun; FRI, 700 m, 22-26.iv.1999, 28♂♂, 5♀♀.
Punjab: Dist. Roopnagar; YH, Roopnagar, 350 m, 21.10.1999, 1♂, 14.vi.2000, 1♂.
Larval host plant: Unknown.

Remarks

Diakonoff (1966) and Horak and Brown (1991) have placed the genus *Anathamna* Meyrick in the tribe Olethreutini owing to characters, particularly connate position of the veins M_3 and CuA_1 in the hindwing. However, in a recent publication, while furnishing a checklist, Horak *et al.* (1996) have rearranged various taxa and have suggested the placement of this genus in the tribe Enarmoniini, the arrangement being followed presently. *Anathamna neospermatophaga* sp. nov. is a very common species in the Western Himalaya.

Etymology

The species is named as *Anathamna neospermatophaga* on the basis of its closeness to an already known species, *A. spermatophaga* Diakonoff and Bradley.

Abbreviations

FRI: Forest Research Institute, NHM: Natural History Museum, UHF: University of Horticulture and Forestry, YH: Youth Hostel

ACKNOWLEDGEMENTS

Dr. Rose is grateful to the Ministry of Environment and Forests, Govt. of India, for funding the project on Microlepidotpera and to the Vice-Chancellor, Punjabi University, Patiala for providing all necessary facilities to set up the Coordinating Centre under an All India Coordinated Project on Taxonomy (AICOPTAX) programme of the Central Government. We are also thankful to Dr. Nieukerken (The Netherlands) for sending a set of publications by late Dr. Alexei Diakonoff. The help and suggestions rendered by Mr. Kevin Tuck (NHM, London) and Dr. Marianne Horak (CSIRO, Australia) is also acknowledged gratefully.

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ENTOMON **30(3)**: 243–247 (2005)
Short Communication No. ent.30309

Comparative studies on male genitalia of three species of *Culex vishnui* subgroup viewed with scanning electron microscope (Diptera: Culicidae)

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ABSTRACT: The male genitalia of three species of mosquitoes belonging to genus *Culex viz., Culex vishnui* Theobald, *Cx. pseudovishnui* Colless and *Cx. tritaeniorhynchus* Giles have been described in detail using scanning electron microscope (SEM). The comparisons of male genitalia among the three species showed differences in the lateral plate of phallosome (ventral cornu, median process, basal or lateral arm), paraprocts and gonocoxites. A key for the identification of these three species based on SEM of male genitalia is also presented.

KEYWORDS: Male genitalia, *Culex vishnui, Cx. pseudovishnui, Cx. tritaeniorhynchus*

Culex tritaeniorhynchus, the chief vector of Japanese encephalitis in India belongs to the *Culex vishnui* subgroup which also includes two other closely related vector species *viz., Culex vishnui* and *Cx. pseudovishnui.* Unfortunately, these three species of the subgroup are so similar that it is very difficult to separate them in order to take suitable control measures against *Cx tritaeniorhynchus*. Therefore, due to their morphological similarity, taxonomic studies with light microscopy are difficult. The presence of morphological variations adds to the problem of identification. Reuben (1969); Reuben *et al.* (1994) tried to separate the members of the subgroup on the basis of extent of black area on the hind femur. Efforts have also been made to study their morphology including structure of male genitalia for recognizing discriminatory characters. The dark area on the femur is variable and, the blackness in the case of *Cx. vishnui* and *Cx. pseudovishnui* only differs in the intensity of the black colour. It is only with practice that the species can be separated on the basis of femoral coloration.

In order to support the use of black color for the separation of the species, stable taxonomic characters from the anatomy are required to be studied. Features pertaining to some parts of the body studied by other workers are quite variable (e.g., the coloration of erect scales of the vertex, mesonotal scales and speckling of pale scales on dark area of the proboscis). The parts of the male genitalia showing differences

TABLE 1. Standard error (SE) of different structures on male genitalia of three species of the genus *Culex*

	Cx. vishnui		*Cx. pseudovishnui*		*Cx. tritaeniorhynchus*	
	Mean	SE	Mean	SE	Mean	SE
1. Ventral cornu	90	0.44a	82	0.42b	25	0.35c
2. Ventro-lateral arm	69	0.41a	62	0.28b	76	0.31c
3(a) Sensilla on gonocoxites	63	0.42a	42	0.41b	72	0.40c
(b) Sensillum	35	0.56a	53	0.41b	80	0.43c
	(Fan-like)		(Wing-like)		(Leaflet)	

Figures followed by different alphabets differ significantly from each other at $P \leq 0.05$ (Students 't' test).

in their structure are not properly appreciated with a light microscope (Sirivanakarn, 1975, 1976). The present investigations on the ultrastructure of the male genitalia have been undertaken for not only evaluating their role in the differentiation of the species but also to supplement the use of black femoral area as an easy approach for the discrimination of the species. The genital structures can be used for confirming the status of different species. Hence, keeping in view the difficulty of accurate identification and the importance of the species of the group as major vectors of a Japanese encephalitis, the present investigations have been carried out.

The mosquitoes were collected from resting places such as cattle sheds, human dwellings, mixed dwellings, and rice fields, using an aspirator, from Ludhiana, Fatehgarh Sahib, Roopnagar, Patiala, Amritsar, Jalandhar, Bathinda and Moga districts of the Punjab state and Union territory, Chandigarh. The region is situated from 29°23′ N to 32°32′ N latitude and 73°55′ E to 76° 50′ E longitude.

The mosquitoes were identified by using the key of (Reuben *et al.*, 1994; Sirivanakarn, 1976) based on femoral coloration and genital structures, respectively. The male genitalia processed in 10% KOH, dehydrated in alcohol and was mounted on SEM specimen stubs. The specimens were sputter coated with gold and scanned under JSM-6100 scanning electron microscope. The photographs were taken at various magnifications ranging from x170 to x13,000 using Ilford Pan 100 B&W photographic films. For each species 25 samples were examined.

The terminology for naming various structures has been adopted from Barraud (1934); Sirivanakarn (1975, 1976) and, Harbach and Knight (1980).

Examination of the male genitalia with the scanning electron microscope has brought to light many hidden and important characters, such as the shape of spines on the ventral cornu, number of finger-like structures on the median process, presence or absence of basal and external process, number of cercal setae on the paraprocts and shape of sensillum on the gonocoxites.

Male genitalia

The ninth segment of the abdomen bears gonocoxites that are without scales but with a subapical lobe bearing various sensilla. The Phallosome is divided into lateral plates

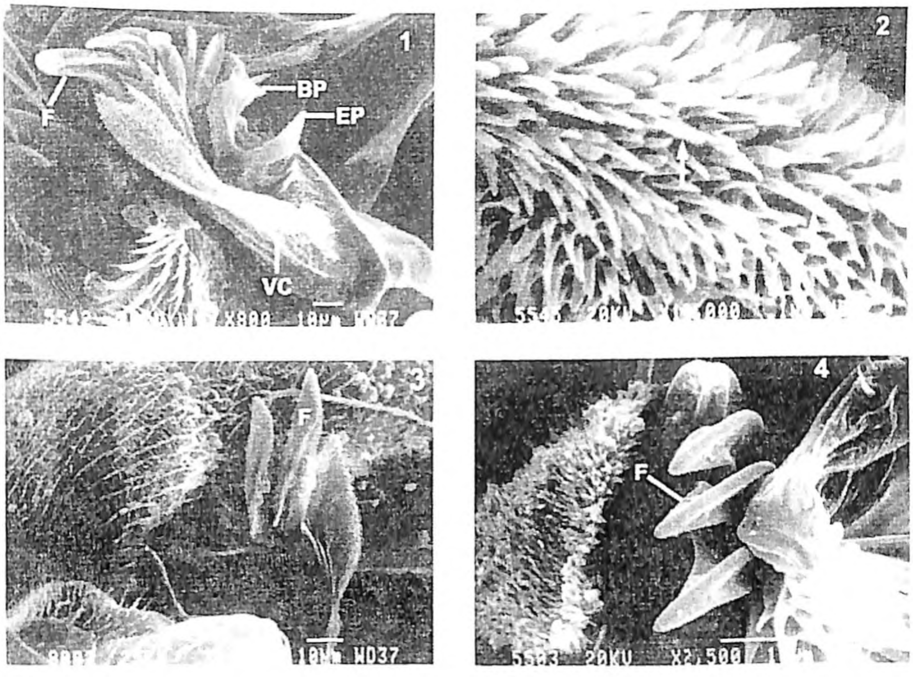

FIGURE 1. Lateral plate of phallosome of *Cx. vishnui* with ventral cornu (VC) and finger-like structures (F) on the median process, Basal process (BP), External Process (EP).

FIGURE 2. Spines on the ventral cornu of *Cx. vishnui* (arrows).

FIGURE 3. Finger–like structures (F) on the median process of lateral plate of phallosome of *Cx. pseudovishnui*.

FIGURE 4. Finger-like structures (F) on the median process of lateral plate of phallosome of *Cx. tritaeniorhynchus*.

and has long pointed apex called ventral cornu and median process. The Paraproct bears numerous spines at its crown and a ventro-lateral arm.

Lateral plate of Phallosome

(a) Ventral cornu and Median Process

In *Culex vishnui*, the ventral cornu is not completely separated from the median process and its length averages 90 μm. The median process of lateral plate of phallosome bears finger-like structures which are nine in number, five of them are long and well developed while four are short (Fig. 1). The surface of the ventral cornu bears minute spines as shown in Fig. 2. In *Cx. pseudovishnui*, the length of the ventral cornu averages 82 μm and it is also not completely separated from the median process and bears spines on its surface. The finger-like structures on the median process are five in number, two of them are quite long and well developed while three are short and

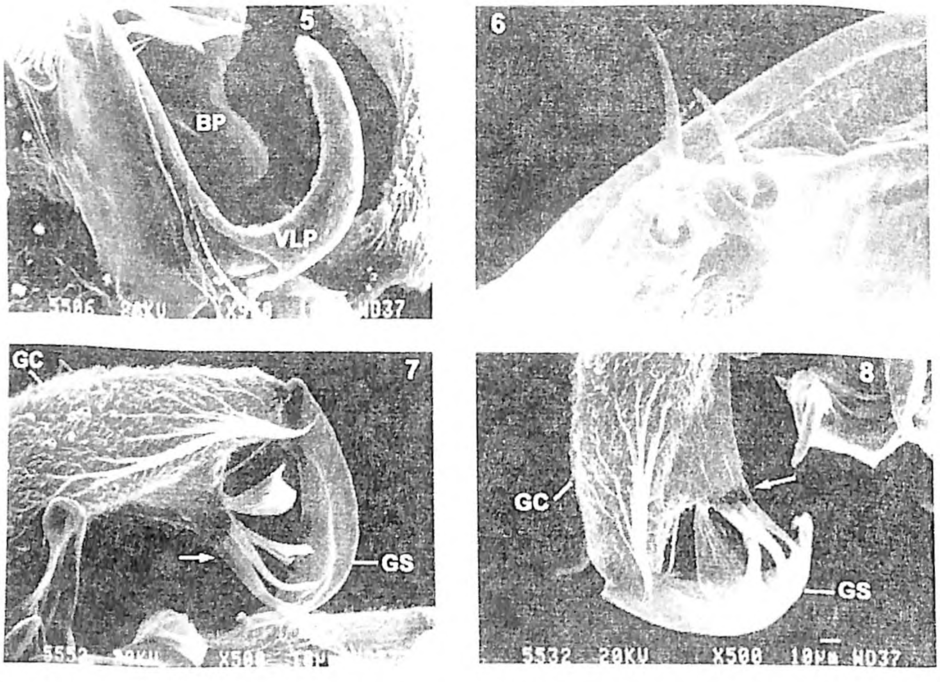

FIGURE 5. Basal process (BP), ventro-lateral arm of paraproct (VLP) of *Cx. tritaeniorhynchus.*

FIGURE 6. Cercal setae on the distal end of paraproct of *Cx. tritaeniorhynchus.*

FIGURE 7. Gonocoxite (GC) with gonostylus (GS) and sensilla (arrows) of *Cx. vishnui.*

FIGURE 8. Gonocoxite (GC) with gonostylus (GS) and sensilla (arrows) of *Cx. pseudovishnui.*

less developed (Fig. 3). In *Cx. tritaeniorhynchus*, the ventral cornu is comparatively short, 25.3 μm in length and is completely separated from the median process and bears minute spines on its surface. The finger-like structures are poorly developed and are just like the spread fingers of a hand (Fig. 4).

(b) Basal, External process and Ventro-lateral arm

In *Cx. vishnui*, the basal and external processes are present and very thickened. In *Cx pseudovishnui* and *Cx. tritaeniorhynch*us, a basal process is present but an external process is absent (Fig. 5). The length of the ventro-lateral arm of the paraproct averages 69.2 μm in *Cx. vishnui*, 62.4 μm in *Cx. pseudovishnui*, and 76.9 μm in *Cx. tritaeniorhynchus.*

(c) Paraprocts

In *Cx. vishnui*, two pairs of cercal setae have been found at the distal and proximal end of the paraprocts. In *Cx. pseudovishnui*, only one cercal seta has been located towards

the distal end (near the crown of spines) while, in *Cx. tritaeniorhynchus*, three setae are present at the distal end (Fig. 6).

(d) Gonocoxites

In *Cx. vishnui*, eight sensilla which average 63 μm in length are present on the subapical lobe of the gonocoxites. Of these, one sensilla is fan like in appearance, with ridges on its surface and 35.3 μm in length (Fig. 7). In *Cx. pseudovishnui*, eight sensilla averaging 42.3 μm in length are present. Out of these, one sensilla is wing like in appearance and 53.8 μm in length (Fig. 8). In *Cx. tritaeniorhynchus*, eight sensilla with an average of 72.5 μm in length are found. One of these sensilla is a leaflet, 80.9 μm in length.

Identification key based on male genitalia of three species of genus *Culex* (viewed under scanning electron microscope)

1. Ventral cornu of the lateral plate of phallosome completely separated from the median process .... *Cx. tritaeniorhynchus.*
– Ventral cornu of the lateral plate of phallosome not completely separated from the median process 2
2. Finger-like structures on the median process nine in number........ *Cx. vishnui.*
– Finger-like structures on the median process five in number
.... *Cx. pseudovishnui*

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Short Communication No. ent.30310

On some new records of Thysanoptera (Insecta) from India

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ABSTRACT: Four species of Thysanoptera, *Coleothrips mongolicus* (Pelikán, 1985), *Scirtothrips mangiferae* Priesner, 1932, *Scolothrips tenuipennis* zur Strassen, 1965, and *Allothrips watsoni* Hood, 1939 are recorded as new from India. The diagnostic characters of the above thrips species are discussed.

KEYWORDS: Thysanoptera, new records, thrips

INTRODUCTION

Thysanoptera fauna of the Indian subcontinent has been extensively studied during the last 50 years and the consolidated collections of thrips from the diversity rich areas of our country have led to the knowledge on the occurrence of about 700 species of thrips (Ananthakrishnan and Sen, 1980; Bhatti, 1990; Sen, 1998). During a recent survey undertaken in the province of Delhi, four species of thrips have been encountered with an appreciable density and their occurrence in India is known only through the present work. They include the Terebrantian species *viz.*, *Coleothrips mongolicus* (Pelikán, 1985) (Aeolothripidae); *Scirtothrips mangiferae* Priesner, 1932 (Thripidae); *Scolothrips tenuipennis* zur Strassen, 1965 (Thripidae); and *Allothrips watsoni* Hood, 1939 (Allothripidae: Phlaeothripoidea). The details of the collection and diagnostic features are discussed here in brief.

Coleothrips mongolicus (Pelikán, 1985)

Aeolothrips mongolicus (Pelikán, 1985), Ann. Hist.-Nat. Mus. Natn. Hungarici, 77: 128–129. Mongolia.

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Coleothrips mongolicus (Pelikán)—Bhatti 1988, Zoology, 1 (2): 116. Transferred to *Coleothrips*.

Female body dark brown. Antennal segment I dark; II dark, pale only at apex; III pale but darkened at apex, at pedicle unshaded; IV dark. Fore wing with 2 dark cross bands alternating with 3 clear areas.

Male bicoloured, with the head, pterothorax, abdominal segment I and VI–X unicolorous dark brown. Prothorax and abdominal segments II–V yellowish. Legs yellow with the mid and hind tibiae dark brown; tarsi shaded dark.

Sensory area on antennal segment IV not arched at apex, reaching middle of segment and reaching the apex of segment; that on segment III not reaching middle of segment. Antennal segment V (75–82 μm long) shorter than segment IV (106–110 μm long); segment V slightly shorter than style (segment VI–IX together, 82 μm long). Pronotal surface smooth, with a few indistinct groove type transverse striae near the posterior margin. Setae S1 on abdominal sternum VII of female more widely separated from each other than from S2, and as long as the latter. Median pair of accessory setae on abdominal sternum VII of female very wide apart from each other, close to the lateral seta on either side.

Male abdominal tergum IX with bidentate claspers. Dorsal plates (appendices) absent on all terga, without any indication. Interstitial bristles situated anterior to claspers, 56 μm long, dark, not surpassing the clasper.

Material studied

219 ♀, 113♂ and 116 larvae; Delhi: Ex. Flowers of *Matthiola incana* (primary host) and *Brassica campestris* (Cruciferae); 15-III-2000; Coll. Vikas.

Distribution

Asia [India (new record), Iran, China, Mongolia, Kazakhstan, Kurdistan].

Scirtothrips mangiferae Priesner, 1932

Scirtothrips mangiferae Priesner, 1932, Bull. Soc. Ent. Egypte, 16: 143–145. Egypt.

Body pale yellow. Head transversely striate, with 2 pair of anteocellar setae. Interocellar setae situated in line with anterior margins of hind ocelli. Antennae 8-segmented, sense cone on segments III and IV forked; segment I without dorsal apical setae. Pronotum transversely striate, with 4 pairs of posteromarginal setae; pronotal posteromarginal setae S2 about 25 μm long. Metanotum with reticulate sculpture at middle. Fore wing clavus with 4 marginal setae, cubitus (lower vein) with 3 or 4 setae, posterior fringe hairs wavy. Tergum VIII and IX with microtrichia medially. Sterna without microtrichia mesad of seta S2. Male with drepanae on tergum IX.

Material studied

144♀ and 19♂, Delhi, 30–IV–2000. 70♀ & 24♂, Gwalior (M.P.), 15–VI–2001. Ex. *Azadirachta indica* (Meliceae).

Distribution

Asia [India (new record), Israel, Iran, Yemen], Africa (Egypt, Libya, Sudan), Europe (Greece).

Scolothrips tenuipennis zur Strassen, 1965

Scolothrips tenuipennis zur Strassen, 1965, Comm. Biol. Soc. Scient. Fennica, 28(6): 30–32. Canary Islands (Grand Canary Island). Described from a single male.
Scolothrips tenuipennis zur Strassen. — zur Strassen 1969, Comm. Biol. Soc. Scient. Fennica, 31(5): 32.
Scolothrips tenuipennis zur Strassen. — zur Strassen 1993, Cour. Forsch-Inst. Senkenberg (CFS Courier), 159: 367. 4♀, 2♂ collected from bases of clumps of the grass *Hyparrhenia hirta*. Characters.

Body small, pale yellow, legs very pale. Antennal segments I and II white, III and IV at base broadly white, otherwise pale gray, segments V to VIII pale gray, segment V of male sometimes basally pale. Wings colourless, without bands.

Head broader than long with 2 pairs of anteocellar setae. Each eye with 5 pigmented facets. Antennae 8-segmented; segment I without dorsal apical setae: II without dorsal seta basad of campaniform sensilla; III and IV with forked sense cones; V with only 2 sense cones. Pronotum with 6 pairs of long setae. Metanotum transversely striate in median third, in lateral parts with longitudinal lines of sculpture; the S1 setae falling far short of the posterior margin of the sclerite. Abdominal tergum I in the median 1/5 with about 5–7 transverse lines, which weakly anastomose, on the left side with a single rather long seta and a campaniform sensillum, both absent on the right side. Sculpture in the median half lacking on terga II–VIII. Abdominal tergum II with 3 lateral marginal setae. Sternum I without setae. Posteromarginal setae on sterna: II with 2 pairs, III–VI and VIII with 3 pairs.

Male abdominal sterna III–VIII each with a narrow, strongly transverse gland area, extending across almost the entire sternum. The 2 pairs of setae across middle of abdominal tergum IX arranged in a slightly arcuate series.

Material studied

5♀, 1♂, 3 larvae; Delhi, Ex. Grass clumps (Poaceae), 3–IX–2002, coll. Vikas and party.

Distribution

India (new record), Atlantic Ocean (Canary Islands, Cape Verdes Islands).

Allothrips watsoni Hood, 1939

Allothrips watsoni Hood, 1939, Revista de Ent, Rio de Jan., 10(3): 600–602. U.S.A. (Florida).
Allothrips watsoni watsoni Hood. — Stannard, 1955, Ann. Ent. Soc. America, 48(3): 155.

Allothrips megacephalus watsoni Hood. — Mound, 1972, J. Australian Ent. Soc., 11: 34.

Major setae on vertex lie behind a line joining the bases of postocular setae. Minor setae on cheeks acute. Tube largely brown. Pelta with transverse sub-basal line of sculpture and lateral reticulations. Antennal segments II and III similar in colour, yellow. S1 setae on tergum IX expanded at apex. Posteromedian setae of pronotum and mesonotum acute.

Stannard used *watsoni* as a species name with 4 subspecies, whereas Mound used the name *watsoni* as a subspecies of *megacephalus* with 7 subspecies including *watsoni*. Both authors used the name for specimens with predominantly brown tube.

The name *watsoni* is now being used as a species name for the reason that Mound's separation of the 2 polytypic species *megacephalus* Hood (1908) and *pillichellus* Priesner (1925) recognized by him was based entirely on the colour of tube, brown in *megacephalus* and with basal half clear yellow in *pillichellus*.

Mound (1972) noted that among over one hundred specimens of *Allothrips* examined by him from Australia, only 2 females were macropterous, but in both of them the distal 'two-thirds' of the fore and hind wings were torn off, and the same was true of a macropterous female of *bicolor* from India seen by him. But for this two macropterous, all the earlier studied by Hood (1939), Stannard (1955) and Mound (1972) were all based on only with apterous form. There are now available a series of macropterous and apterous individuals of both sexes collected in Delhi from branches of shrubs, which are being allocated to *watsoni*.

Female (macropterous, partially dealeated). *Colour.* Body bicoloured. Head, thorax and abdominal segment I yellow, abdominal segments II to IX brown and X light brown with grayish brown apex. Antennal segment I to III yellow, IV pale brownish, V to VII brown. Legs yellow. Wings clear, transparent. Setae unshaded.

Structure Head longer than broad, distinctly produced in front of eyes. Dorsum of head smooth except for a few transverse lines anteriorly and faint reticulation at base of head. Postocular setae well developed, expanded at apex. Major setae on vertex lie behind a line joining bases of postocular setae. Head with several pairs of minor setae on cheeks which are acute. Proboscis broadly rounded.

Antennae 7-segmented, morphological segments VII and VIII completely fused. Segments III and IV each with 2 sense cones.

Maxillary stylets broad, band-like, retracted far into the head, wide apart from each other. Maxillary bridge absent.

Notopleural sutures incomplete. Surface of prothorax largely smooth, weakly sculptured along posterior margin. All dorsal prothoracic setae well developed and expanded at apex. Posteromedian setae acute. Fore coxa with a well developed seta, similar to the major pronotal setae. Basantral plates present.

Mesopresternum degenerate at middle. Mesonotum at each lateral angle with a well developed apically dilated seta, other setae short and acute. Metanotal setae of group *a*

well developed and expanded at apex, 3 minute setae of group *b* sublaterally on either side, group *c* setae absent.

Fore tarsus unarmed. Wing basal setae expanded at apex, arranged in a right angle. All wings have retained only the basal part, beyond which they are cut off.

Pelta broad, with reticulations on sides, similar to that described above for *watsoni* aptera, and in a narrow strip along posterior margin. Terga IV to VI each with one pair of well developed sigmoid setae, anterior pair absent. S1 setae on tergum IX expanded at apex, about as long the tergum, S2 setae much longer and thinned out but ending in a somewhat blunt tip.

Female (apterous). Wings and ocelli absent. Colour similar to macropterous female. Mesonotum laterally with 3 long setae, expanded at apex. Metanotal setae of group *a* well developed and expanded at apex, setae of group *b* and group *c* absent. Wings and ocelli absent. Sigmoid setae absent on terga.

Male (macropterous, partially dealeated). Colour and structure similar to macropterous female. Abdominal sternum VIII without gland area.

Male (apterous). Colour and structure similar to apterous female. Abdominal sternum VIII without gland area.

Material Studied

15♀ macropterous, partially dealeated (md), 93♀ apterous (a), 1♂ macropterous, partially dealeated (md), 14♂ apterous (a), Delhi, Ex. twigs of *Grewia tenax*, *Thevetia peruviana* and prop roots of *Ficus benghalensis*; 5-vii-2001, coll. Vikas.

Distribution

U.S.A., India-Delhi (new record)

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Short Communication No. ent.30311

First record of the genus *Wilhelmina* schmitz and villeneuve from India with description of a new species (Diptera: Calliphoridae)

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ABSTRACT: The genus *Wilhelmina* Schmitz and Villeneuve is reported for the first time from India with the description of a new species i.e. *Wilhelmina indica* sp. nov. The female genitalia and chaetotaxy of thorax is illustrated and this new species is differentiated from the already known species of this genus.

KEYWORDS: New spacies, *Wilhelmina*, Diptera, Calliphoridae

The monotypic genus *Wilhelmina* Schmitz and Villeneuve was known so far only from Borneo. The adults of *Wilhelmina nepenthicola* Schmitz and Villeneuve were reared from the larvae found in the pitchers of *Nepenthes*. The larvae of this species are unique and have been well illustrated by the authors. Senior-White *et al.* (1940) followed the diagnosis of this genus as given by the original authors.

Wilhelmina indica sp. nov. (Figs 1–4).

Female

Body length 9.5 mm.

Head

Eyes bare, dichoptic facets uniform, extending upto genae; frons reddish brown, wider than parafrontalia, with short fine hair; parafrontalia covered with silver grey tomentum; frontal bristles well developed; fronto-orbital bristles present; ocellus with weak ocellar and postvertical bristles; vertical bristles well developed; outervertical bristles reduced; prevertical bristles absent; parafacialia, face, epistome, jowls and genae covered with silver grey tomentum, bare; facial carina absent; medianae orange; genae and postgenae silver grey, with black hairs; vibrissae present at level with oral margin; peristomal bristles well developed; postorbit black, bare; occiput with soft

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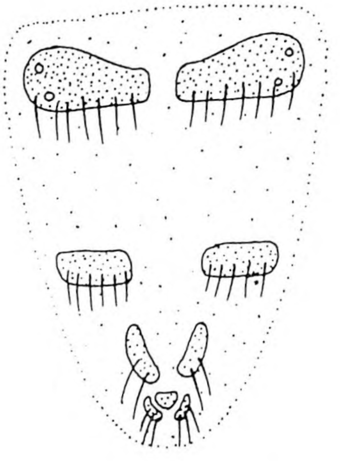

FIGURE 1. Dorsal view of ovipositor (magnification line=0.4 mm).

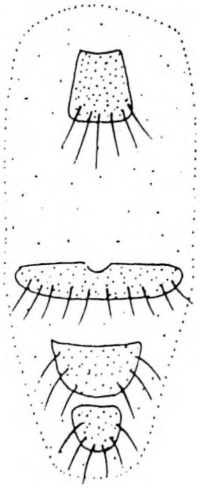

FIGURE 2. Ventral view of ovipositor (magnification line=0.4 mm).

black and pale hair; 1st and 2nd antennal segments black, 2nd segment setulose with 2 long bristles, 3rd segment dark brown with orange base; length of 3rd segment about 3.25X that of 2nd; arista dark brown, short plumose on 3/4th of it length; palpi dark brown, bare.

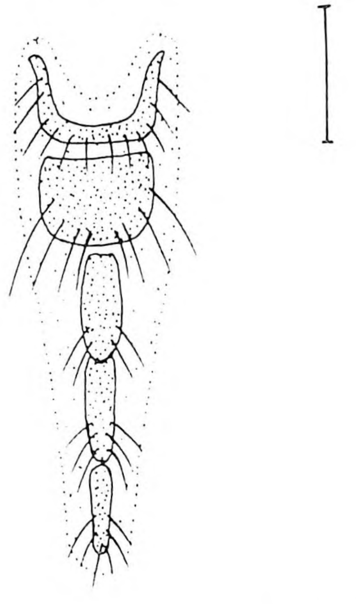

FIGURE 3. Sternites 1–5 of female (magnification line=0.75 mm).

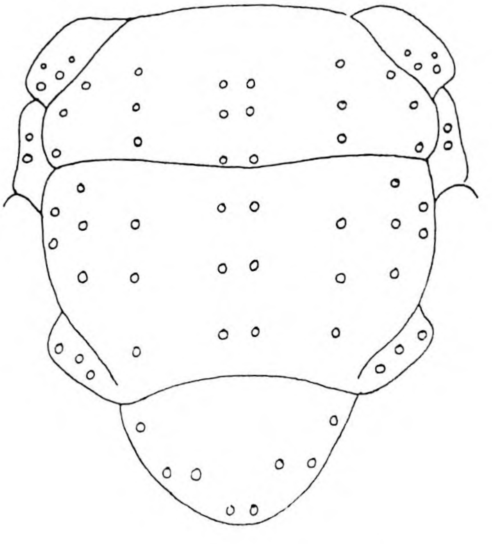

FIGURE 4. Dorsal view of chaetotaxy of thorax (diagramatic).

Thorax

Metallic black with a dark mark across suture and base of scutellum, with heavy grey dusting; humerus grey dusted; postalar callus black; propleuron and prosternum bare; postalar declivity hairy; supraspiracular convexity hairy; suprasquamal ridge bare.

Chaetotaxy (Figs 4) Acrostichals 3 + 3; dorsocentrals 3 + 3, intra-alars 0 + 3; presutural present; humerals 4; posthumerals 2; supra-alars 2; post-alars 3; notopleurals 2; lateroscutellars 2; apicoscutellar and discoscutellar 1 each; sternopleurals 1 + 1; propleural and prostigmatic present,

Wings

Hyaline, with yellowish tinge; veins brown, stem vein (r) bare; R_1 bare; R_{4+5} blackish setulose upto halfway of R-M on both dorsal and ventral sides; first posterior cell (R_5) closed at wing tip; epaulet and basicosta black; subcostal sclerite with short black hair; alar and thoracic squamae waxy white, thoracic squama large with yellow pale hair on outer margins; halteres brown.

Legs

Black with black hair except, tibiae and pullvilli brown; femora covered with bristles on both dorsal and ventral sides; foretibia with 1 brsitle at middle and 2 at apex; midtibia with 1 bristle at middle and 3 at apex; hindtibia with 2 bristles at middle and 1 at apex.

Abdomen

Testaceous black with silver dusting on tergites 3 and 4; tergites 2 and 3 with marginal bristles on lateral sides only; tergites 4 and 5 with series of marginal bristles and numerous long hair; sternites 1–5 with long hair; hypopygium inconspicuous. Sternites 1–5 (Fig. 3).

Female genitalia

Dorsal view of ovipositor (Fig. 1).
Ventra view of ovipositor (Fig. 2).

Male

Unknown.

Holotype

Female, ***Uttaranchal***: Almora-1650 M, 10.x.2001. Coll. Inderpal Singh Sidhu.

Remarks

This new species represents the first record of genus *Wilhelmina* from India. It can be differentiated from the type species on the basis of following combination of characters: length of 3rd antennal segment only 3X that of 2nd (5X in *nepenthicola*); acrostichals 3 + 3 (2 + 3 in *nepenthicola*); supra-alars 2 (3 in *nepenthicola*); halteres brown (pale yellow in *nepenthicola*). Unfortunately, the diagrams for the external genitalia of *W. nepenthicola* Schmitz and Velleneuve are not available for comparison.

Etymology

The name of the species is derived from country's name.

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Natural enemies of *Diaphania indica* (Saunders) (Pyralidae: Lepidoptera) in Karnataka

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ABSTRACT: *Diaphainia indica* (Pyralidae: Lepidoptera) is a serious pest of Gerkins (*Cucumis anguria* L. Family: Cucurbitaceae) or pickling cucumber, a major export oriented crop of India. Four natural enemies, *Trichogramma chilonis*, *Dolichogenidea stantoni*, larval–pupal parasitoid *Xanthopimpla punctata Fabr* and the entomopathogen *Nomurea rileyi* were recorded from the eggs and larval stages of the pest. *T. chilonis* and *Nomurea rileyii* are new records on *D. indica* from India.

KEYWORDS: *Diaphania indica*, cucurbits and gourds, *Trichogramma chilonis*, *Nomurea rileyii*, first record, biological control

Among the cucurbits, gherkins (*Cucumis anguria* L. Family: Cucurbitaceae) or *pickling* cucumber introduced to India during early part of 1990's is presently a major export oriented crop. The tender fruits are used for pickling in brine or vinegar and are in demand abroad. Among the different states cultivating the crop, Karnataka contribute 90 per cent of the country's production.

Among the causative agents affecting its production, the bud and fruit borer, *Diaphania indica* (Saunders) is considered as a major factor (Ravi *et al.*, 1997). Females lay eggs on the under surface of the leaves. The early larval instars feed on the tender leaves, while the later instars feed on the leaves, buds and tunnels through the tender fruit. The larvae were found aggregating on the under surface of the leaves. The pest occurs throughout the year on different cucurbitaceous crops. Its incidence on gherkins is at its peak from July to October in Karnataka (Ravi *et al.*, 1998).

Taking into consideration the need to manage the pest by non-toxic environment friendly methods, survey for potential biological control agents of *D. indica* was carried out in and around Karnataka state in 2003–04.

Different stages of the pest, eggs larvae and pupae collected from the field. Care was taken to collect the insect stages from fields that were free from any pesticide application. The samples were held in plastic containers in the laboratory. Larvae were fed with the respective host plant leaves in the laboratory till pupation. Un-hatched

eggs, dead, moribund larvae, un-emerged pupae were isolated and observed for the causative mortality *factors* (parasite and pathogens).

The natural enemies recorded from different stages of the insect are the egg parasitoid *Trichogramma chilonis*, larval parasitoid *Dolichogenidea stantoni* Ashmead, larval pupal parasitoid (*Xanthopimpla punctata Fabr*), and an entomopathogen, *Nomurea rileyii*. Of these, the larval parasitoid *A. stantoni* and *T. chilonis* were found occurring throughout the year on ridge gourd, causing a maximum of 51.00 and 49.84 per cent mortality respectively. Mortality by other natural enemies ranged from 0.01 to 10 per cent only. The incidence of natural enemies were found to be comparatively more on ridge gourd than on cucumber, bitter gourd and melons.

Peter and David (1991) have reported about 20 species of parasitoids from *D. indica* infesting *Coccinia grandis* and cucumber in Tamil Nadu. Narayanan and Veena Kumari (2003) reported an NPV from *D. india*. The present record of *Trichogramma chilonis* and fungus *N. rileyii* appears to be first from India. An egg parasitoid *Trichogramma confusum* was recorded from *D. indica* from China (Ke *et al.*, 1986).

The exploitation of these bio-control agents for the management of *D. indica* would be desirable to ensure production of pesticide free gherkins for export.

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Ant diversity in sponge gourd and cauliflower agroecosystems and the potential of predatory ants in insect pest management

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ABSTRACT: Ant diversity was investigated in sponge gourd, *Luffa cylindrica* and cauliflower, *Brassica oleracia* var. *botrytis*, agroecosystems. Twelve ant species were recorded from sponge gourd fields and ten ant species from the cauliflower fields in the all-out search and pit-fall traps yielded five and seven ant species respectively. The most widespread ant species was *Pheidole* sp.1. Among the nine predatory ant species localised, four ant species *viz. Pheidole* sp.1, *Aphaenogaster* sp.1, *Pachycondyla* sp.1 and *Camponotus* sp.1 were found to prey upon major pests of the crops.

KEYWORDS: ants, biological control, sponge gourd, cauliflower

Ants are the earliest biological control agents used for the control of insect pests. Except for a few isolated studies (Taley and Garg, 1973; Rosy and Narendran, 1985, Veeresh and Rajanna, 1981) the role of ants in pest control has been largely overlooked in India. In the present study, ant diversity was examined in sponge gourd and cauliflower agroecosystems and preliminary observations on the predation of insect pests of the crops were made.

The study was carried out in farmers' fields in Madhauli village, Varanasi from March 2003 to March 2004. Ants were collected from five fields (125 m^2 area) by the following two methods: (a) all-out search method- ants were collected twice each month by walking through the fields from 6–10 a.m. and 2–6 p.m. during the crop season and collecting worker ants of all species seen there (b) Pit-fall traps- Twenty pit-fall traps (four per field) were placed in the fields during pre-flowering, flowering and fruiting stages of each crop. A 2.5-liter plastic jar containing 700 ml of 0.05% methyl parathion solution was buried at ground level. Traps were placed between 7 a.m. and 9 a.m. and the catch was collected after 24 h and the ants were washed and transferred to 70% alcohol. To collect predatory ants, baits were used (15 baits per field) each comprising freshly killed grasshoppers (five grasshoppers per bait) and

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worker ants of the species visiting the baits were collected and identified. All ants were identified up to genus level. Ants species observed preying on the insect pests under field conditions were recorded.

Twelve ant species belonging to nine genera and six sub-families were collected from sponge gourd fields in the all out search (Table 1). From the cauliflower fields the search yielded ten ant species belonging to seven genera and four sub-families. On the other hand, pit-fall traps yielded five ant species representing four genera and three sub-families in the sponge gourd fields while the traps from the cauliflower fields provided seven ant species belonging to five genera and four sub-families. The most common, widespread and abundant (range: 44–71% in sponge gourd and 45–64% in cauliflower fields, respectively) ant species was found to be *Pheidole* sp. 1

At the baits, eight predatory ant species- *Pheidole* sp. 1, *Aphaenogaster* sp. 1, *Camponotus* sp. 1, *Camponotus* sp. 2, *Camponotus* sp. 3, *Tapinoma* sp. 1, *Pachycondyla* sp. 1, and *Monomorium* sp. 1 were found in the sponge gourd fields. In cauliflower fields, an additional ninth species, *Tetramorium* sp. 1 was also found.

Under natural field conditions, worker ants of *Pheidole* sp. 1 were observed capturing adults of the red pumpkin beetle, *Raphidopalpa foveicollis* (Lucas) ($n = 4$), unidentified lepidopteran larvae ($n = 5$) while *Pachycondyla* sp. 1 workers were observed preying upon the larval stages of *H. armigera* ($n = 2$) and *Agrotis* sp. ($n = 3$) in the sponge gourd fields. In the cauliflower fields, *Pheidole* sp. 1 were observed preying upon *B. brassicae* ($n = 12$), adult of *P. xylostella* ($n = 1$), as well as unidentified lepidopteran larvae ($n = 13$) and adults ($n = 3$). *Aphaenogaster* sp. 1 workers were observed to prey on first instar larvae of *P.xylostella* ($n = 1$) and *Agrotis* sp. ($n = 3$). Workers ants of *Camponotus* sp. 1 were observed preying on pupae of *P. xylostella* ($n = 2$), larvae of *H. armigera* ($n = 7$) and also on unidentified lepidopteran larvae ($n = 7$).

DISCUSSION

Table 1 reveals that twelve ant species belonging to five sub-families and ten ant species belonging to four sub-families comprise the ant community in sponge gourd and cauliflower agroecosystems respectively. Of these, nine ant species were found to be predatory.

Among the predatory ants, *Pheidole* sp. 1 was the most widespread and abundant ant species occurring throughout from pre-flowering to fruit formation stage, in both agroecosystems. Interestingly, while *Pheidole* sp. 1 has been found to be an ecologically dominant ant species in an earlier study (Rastogi, 2005), *P. megacephala* has been reported to be a polyphagous ant species (Greenslade, 1972) preying on more than 20 species of arthropods (Perfecto and Castiñeiras, 1998). Due to its effectiveness as a biological control agent for sweet potato weevil *Cyclas formicarius elegantulus* (Summ.) and the banana weevil *Cosmopolites sordidus* (Germ.) (Castiñeiras *et al.*, 1991a,b) vegetable growers in Cuba, protect and maintain reservoirs of the ant colonies, which are transported to the field, whenever required.

TABLE 1. Ants collected from the ground by all-out search and pit-fall trap methods from sponge gourd and cauliflower agroecosystems

Sub-family and ant species	Abundance	Ant species: Ants in all-out search collection		% of ants in pit fall trap collection					
		In sponge gourd field	In cauliflower field	In sponge gourd field			In cauliflower field		
				A	B	C	A	B	C
Ponerinae									
Pachycondyla sp. 1	Common	+	+	2.32	–	4.4	–	2.1	–
Pseudomyrmicinae									
Tetraponera sp. 1	Occasional	+	–	–	–	–	–	–	–
Dorylinae									
Dorylus sp. 1	Rare	+	–	–	–	–	–	–	–
Myrmicinae									
Crematogaster sp. 1	Occasional	+	–	–	–	–	–	–	–
Monomorium sp. 1	Occasional	+	+	–	–	–	–	–	–
Pheidole sp. 1	Common, very abundant	+	+	48.6	44.1	70.8	54.3	63.8	45.0
Aphaenogaster sp. 1	Common, abundant	+	+	35.4	39.9	–	–	–	20.8
Tetramorium sp. 1	Occasionaly common	–	+	–	–	–	–	–	–
Dolichoderinae									
Tapinoma sp. 1	Occasionaly common	+	+	–	–	–	9.8	7.0	6.1
Formicinae									
Camponotus sp. 1	Common, abundant	+	+	11.4	16.0	24.9	18.7	17.3	20.5
Camponotus sp. 2	Common	+	+	–	–	–	8.9	7.6	5.5
Camponotus sp. 3	Occasional	+	+	2.32	–	–	8.3	2.3	1.5
Camponotus sp. 4	Occasional	+	+	–	–	–	–	–	–

+ denotes presence of specific ant species in the agroecosystem; – denotes absence of specific ant species in the agroecosystem; * found in freshly dug ground; **A** – Pre-flowering stage **B** – flowering stage **C** – fruiting stage

In India, *Pheidole* sp. 1 has been recorded as a predator of the diamondback moth (Jayarathnam, 1977) while *Camponotus compressus* and *C. sericeus* have found preying upon cutworms (Veeresh and Rajanna, 1981; Rajagopal and Musthak Ali, 1984). *Tapinoma melanocephalum* has been reported to prey on the sorghum midge (Taley and Garg, 1973) as well as on *P. xylostella* and *Agrotis*, *Heliothis* and *Plusia* larvae (Jayarathnam, 1977; Margal and ChannaBasavanna, 1979; Mushtak Ali, 1981; Veeresh and Rajanna, 1981).

This investigation shows that of the nine predatory ant species observed, at least four ant species belonging to the genera *Pheidole*, *Aphaenogaster*, *Camponotus* and *Pachycondyla* are particularly good candidates for conservation biological control of insect pests of sponge gourd and cauliflower due to their generalist predatory nature and widespread occurrence in the agroecosystem.

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Life history of the rubber beetle *Luprops curticollis* Fairmaire (Coleoptera: Tenebrionidae)

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ABSTRACT: The rubber beetle, *Luprops curticollis* Fairmaire (generic name mis-spelt as *Lyprops* in earlier reports) found hiding in large swarms on the wooden roofs of houses during the months of March/April leave the settlements in December for breeding in rubber plantations. Eggs are laid in clusters in decaying leaf litter, especially in rubber estates. There are five larval instars and a short prepupal stage. The adults emerge in February and reach the settlements by the end of this month and stay there till December.

KEYWORDS: *Luprops curticollis*, life cycle, habits

Luprops curticollis (Coleoptera: Tenebrionidae) is a small beetle, the adults of which crowd in large numbers on the roofs of houses in settlements near rubber plantations in Kerala. It was earlier known under the mis-spelt generic name *Lyprops* (Gardner, 1929; Beeson, 1941; Narendran, 1998). The generic name *Luprops* was confirmed by Warren Steiner of the US National Museum, from the 1937 Gebian Catalogue (personal communication to Dr. T. C. Narendran). Schawaller (1997) has given a checklist of six species of *Luprops* reported from India. Beeson (1941); Narendran (1998) have given information on the adult habits of *L. curticollis*. The insect is believed to breed on leaf litter in rubber plantations but detailed information on the breeding habits and biology of the immature stages are not available. Hence the present investigation was undertaken to gather information on its life history.

The study was carried out in rubber plantations and neighboring houses, near Punalur in Pathanamthitta District, about 100 km from Trivandrum in Kerala. The adults were monitored when they started leaving the roofs of houses where they hide. They were traced and found to lay eggs in litter in rubber plantations and follow-up observations were made.

*Corresponding author

FIGURE 1. Eggs from litter.

FIGURE 2. First instar larva x100.

In December, most of the rubber trees shed their leaves. The breeding of this beetle coincided with the leaf shedding. During January, the females were found to lay eggs in the litter. Usually the eggs were laid on the under- surface of fallen leaves in clusters. The egg laying period lasted one month. Eggs are elongate, measure about 1 mm in length (Fig. 1). They have a concave anterior pole and a convex posterior pole and are creamy white. The eggs took 4 days to hatch . The larvae feed on the decaying rubber leaves. There are five larval stages. The larvae are elongated eruciform and body is covered with thick tuft of hairs The first instar larva (Fig. 2) is 1 to 1.5 mm long, delicate and creamy white. Before moulting its colour changed to wheatish. From the second instar onwards, the colour is brown and it deepens in the subsequent stages and

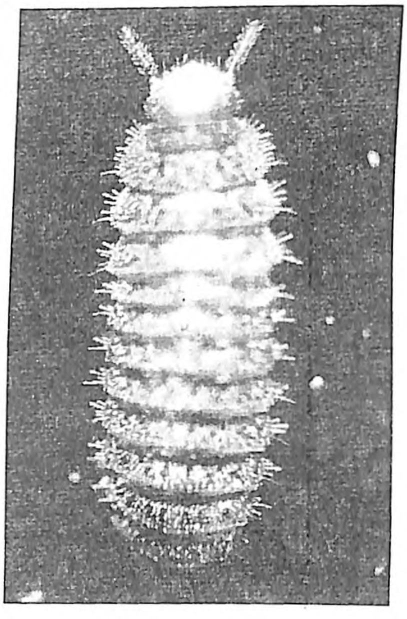

FIGURE 3. Second instar larva x100.

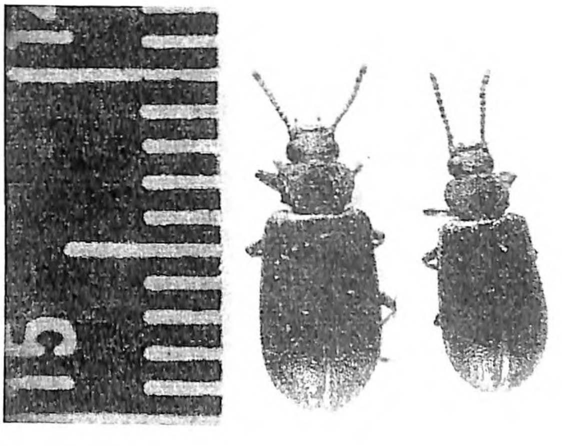

FIGURE 4. Adults female and male.

the larvae have a thick covering of hairs even extending to antennae. The length varied from 2 mm to 6 mm. The duration of the first, second (Fig. 3), third and fourth instars averaged 4 days. The fifth instar larvae took nine days to enter into the prepupal stage which lasted for 4–5 hours before the pupa was formed . The pupal period lasted for five days. Adult males are smaller in size and measure about 7 mm in length compared

to females which are 8–9 mm (Fig. 4). The newly emerged adults remain in leaf litter for 4–5 days before they move away in swarms.

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Level of natural parasitisation of *Melanagromyza obtusa* (Malloch) (Diptera: Agromyzidae) on pigeonpea at Hisar

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ABSTRACT: The larval-pupal parasitoid *Euderus lividus* Ashmead and the pupal-parasitoid *Eurytoma* sp. were recorded on *Melanagromyza obtusa* at Hisar. The range of parasitisation being 5.45 to 10.00 and 3.69 to 5.00 per cent, respectively. The activity of both the parasitoids started from first week of October and reached maximum during later half of the month. The parasitisation synchronized with the occurrence of immature stages of the host. © 2005 Association for Advancement of Entomology

KEYWORDS: *Melanagromyza obtusa*, *Euderus lividus*, *Eurytoma* sp., Parasitisation, Pigeonpea

Among the pests of pigeonpea, pod fly, *Melanagromyza obtusa* (Malloch) [Agromyzidae; Diptera] is the most serious. Srivastava (1972) reported that the fly causes 34.5 per cent damage to the pods resulting in 29.8 per cent loss to grains. The management of the pod fly is crucial for the realization of the production potential of the varieties. The use of natural enemies of the pod fly, as biological control agents for its management is a promising and viable strategy (Singh, 1994). Studies were therefore, conducted to assess the level of natural parasitisation of *M. obtusa* on pigeonpea and to identify the promising candidates for bio-control of the pest.

The experiment was conducted at CCS HAU, Hisar research farm in Kharif 2002 from 5 × 4 m plots. 250 pods were randomly collected from five plants at 10, 20 and 30 days after flowering and brought to Laboratory. The pods bearing larvae and pupae of *M. obtusa* were kept separately in covered Petri-dishes for observing the emergence of pod fly and its parasitoids. The parasitisation percentage was calculated.

The parasitoids recorded during the survey were the larval-pupal parasitoid *Euderus lividus* Ashmead and the pupal parasitoid *Eurytoma* sp. The level of parasitisation was observed zero at 10 days after flowering (last week of September) whereas, it was 5.45 and 3.63 per cent by *E. lividus* and *Eurytoma* sp., respectively at 20 days after flowering (first week of October) and 10.00 and 5.00 per cent, respectively at

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30 days after flowering (second week of October). The present results corroborate the earlier reports of similar degree of parasitisation by the two species (Singh and Beri, 1971; Ipe, 1974; Sithanantham *et al.*, 1983). Ahmad (1940) however, reported comparatively higher parasitisation (up to 50%) by *E. lividus* at Delhi, while Sebastian (1993) recorded low parasitisation level by *E. lividus* (7.3%) and *Eurytoma* sp. (2.5%) from Kerala.

The parasitisation was observed to be at peak during later half of October in the present investigation. This finding contradicts the work done by Ahmad (1938, 1940); Singh and Beri (1971); Ipe (1974) recorded peak parasitisation during the months of March and April. This may be due to the cultivation of extra early varieties under Hisar conditions which are harvested by the first half of November as compared to other regions where late varieties were grower. Hence, the appearance of the parasitoids short duration pigeonpea at Hisar seems to often synchronize with the availability of vulnerable stages of the host (Singh, 1992).

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Effect of commonly used insecticides on the pigeonpea podfly *Melanagromyza obtusa* (Malloch) and its parasitoids

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ABSTRACT: The most commonly used insecticides *viz*: dimethoate 0.03%, monocrotophos 0.04%, acephate 0.07%, profenophos 0.21%, endosulfan 0.07% along with NSKE were evaluated for their performance and safety. With reference to grain damage all the synthetic insecticides were equally effective and NSKE was inferior. Profenophos and dimethoate were relatively safer to parasitoids than endosulfan and monocrotophos.

KEYWORDS: *Melanagromyza obtusa*, pigeonpea, endosulfan, monocrotophos, profenophos, dimethoate, NSKE, nontarget effect

Pigeonpea is one of the most important pulse crops. It ranks second contributing over 90% of the world pigeonpea production. *Melanagromyza obtusa* Malloch is the key pest in late maturing pigeonpea causing heavy crop losses in India Till date, chemicals are the only available efficient strategy against *M. obtusa*. A wide range of chemical insecticides has been tested, most frequently as liquid formulations. Systemic insecticides are the better choice to control the podfly because of its concealed feeding harvest of the pest. Patel and Patel (1989); Bhadauria *et al.* (1991); Reddy *et al.* (2001). Information on the toxicity of these chemicals, in relation to immature as well as adult stages of the pest and the key natural enemies is lacking and needs to be generated to make the pest control more effective and eco-friendly (Lal and Katti, 1997). In this study we examined the efficacy and safety of commonly used insecticides along with NSKE.

The study was conducted at Indian Institute of Pulses Research, Kanpur, India. The pigeonpea variety Bahar was sown in randomized plots (15 × 10 m), replicated thrice, for two consecutive cropping seasons of 2000–01 and 2001–02. Five insecticides

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TABLE 1. Screening of insecticides against podfly and its parasitoids (2000–2002)

Treatment	Dose (%)	Grain damage (%)			Parasitization (%)			Yield (kg/ha)		
		2000–01	2001–02	Mean	2000–01	2001–02	Mean	2000–01	2001–02	Mean
Acephate	0.07	16.1 (23.6)	12.0 (19.2)	14.0	14.9 (22.7)	12.5 (20.7)	13.7	1503	1524	1513
Dimethoate	0.03	12.8 (20.9)	12.5 (20.7)	12.6	17.5 (24.7)	14.8 (22.6)	16.1	1623	1911	1767
Endosulfan	0.07	19.1 (25.9)	15.4 (20.3)	17.2	9.9 (18.3)	9.0 (17.5)	9.4	1462	1463	1462
Profenophos	0.1	12.4 (20.6)	10.8 (23.1)	11.6	16.3 (25.6)	15.5 (23.2)	15.9	1684	1936	1810
Monocrotophos	0.04	14.4 (22.3)	11.6 (19.9)	13.0	8.3 (16.7)	9.0 (17.5)	8.6	1530	1862	1696
NSKE	5%	23.5 (29.0)	19.2 (26.0)	21.3	18.6 (23.8)	17.2 (24.5)	17.9	1138	1240	1189
Control	–	36.7 (37.3)	31.6 (34.2)	34.1	19.9 (27.1)	19.5 (26.2)	19.7	911	1062	986
CD at 5%	–	4.3	4.3	–	3.2	2.1	–	216.5	140	–

viz., dimethoate 0.03%, monocrotophos 0.04%, acephate 0.07%, profenophos 0.21%, endosulfan 0.07% and NSKE 5% were compared with untreated control (check). The treatments were applied thrice and the first spray was done at the time of 50% pod primordial stage. From each plot, 50 randomly collected pods were examined daily for a particular week so as to record parasitoids, if any. Similarly, the resting stages (pupae) were also collected and subsequently reared in atmospheric chamber till the emergence of podfly adults and/or parasitoids. The grain damage was judged by counting the number of damaged grains out of 500 randomly collected pods from each plot at maturity.

Profenophos was most effective in minimizing the grain damage followed by dimethoate, monocrotophos, acephate, endosulfan and NSKE. All these treatments were significantly superior to control. Maximum yield was attributed to profenophos followed by dimethoate and monocrotophos. Nonetheless, the other treatments; acephate, endosulfan and NSKE could also show a significant effect on yield component. NSKE dimethoate and profenophos did not show deleterious effect on parasitoids as evidenced from their values being statistically at par with untreated check. Conversely, endosulfan and monocrotophos exerted their direct bearing on parasitoids (Table 1).

The impact of pesticides on natural enemies of podfly has not been studied so far (Shanower *et al.*, 1998). Our results indicated that dimethoate, prefenophos and NSKE were relatively safer to the parasitoids of podfly and also gave effective control of podfly. Endosulfan and monocrotophos on the other hand, proved to be toxic to the natural enemies of podfly.

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